POWER

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A Merry Christmas

FROM thousands of lips this hail will pass and thousands of hearts will feel the spell of this season, of bounteous good cheer and thoughtfulness for others.

"On earth peace; good will toward men."

To a war-torn world, when tribes and nations rested from one war only to prepare for another and men lived in continual dread of a call to arms, what sweeter vision could have been invoked than that of settled and eternal peace?

The chance to live secure and undisturbed among one's people, to develop one's own possibilities and those of one's surroundings, to have time for culture and development, to make and produce and feel secure in the possession of the products of one's toil and talent.

It was a sympathetic chord that the Prince of Peace touched in the hearts of men.

And his recipe was so simple — just Good Will. There can be no war between men whose will toward one another is good.

There could be none of the abuses, the taking of mean advantages, the selfish trampling of the rights of others, the stings of thoughtlessness that make up the shadows of life, if all were actuated by that simple spirit of good will toward others of which He was the self-sacrificing example.

The prevalence at this time of this spirit of genial good will is what marks the Christmas Season and makes it distinctive among our festivals.

May its celebration strengthen this spirit in us all through the year that is to come!

F. R. Low

Office-Building Plant Saves by Studying Costs

By WILLIAM R. GOODWIN

THE first step was to put everything in order and install meters and a system of records. The second step was to study these records month by month to determine the most economical method of operation. As a result of this study, motor-generator sets were installed for the purchase of power in excess of that capable of being generated from heating steam.

IF AN "isolated plant" is situated in the center of a municipality, where there is an up-to-date and progressive central station, is it cheaper to operate the isolated plant or to abandon it for purchased power, or may neither of these courses fulfill the desire for maximum economy?

The Connecticut Mutual Life Insurance Company[1] erected its home office building in Hartford (Conn.) in 1870 and in 1901 built an addition greatly increasing the size of the structure. Situated in the business center of Hartford, this building is considered one of the finest of its kind in New England, and in addition to the insurance company there are many prominent and widely known concerns and business men who have their offices there.

At the time the addition to the building was made in 1901, an up-to-date power plant was installed to supply the heat, light and power demands of the entire building. This plant consisted of three horizontal return-tubular boilers and three direct-connected engine-generator units, to which there was recently added a 140-kw. unaflow engine-generator unit. All these are direct-current, 110-volt machines. The auxiliary equipment consisted of the usual feed-water pumps and heaters, with vacuum pumps for the heating system.

In July, 1923, the writer became mechanical superintendent of this building and found, as one of the first problems to be met, the contention of the power sales engineer of the local electric power company, that the operation of the plant as it existed was not economical. The owners of the building held the opposite opinion. Neither had any substantial or authentic data to prove their contentions.

As already stated, the entire demand for electricity was carried by the plant. The building was heated by the exhaust steam from the engines, this generally being quite sufficient for all demands, except on very cold winter mornings, when live steam was used for a short time only. At all times during the day, however, there was an excess of exhaust steam which was wasted to the atmosphere. The exhaust steam was also used to heat the boiler feed water. In the summer this was the only use made of it, the excess being wasted to the air.

The condensation from the heating system was brought back to vacuum return pumps in the boiler room and was pumped to the boilers. Two boilers were kept fired all the time, while a third was shut down. Each week a change was made, so that by rotation the next boiler was shut down and the remaining two operated. The boilers were fired during the day, and one of them was banked at 6:30 p.m. and started up at 5:30 a.m. This schedule was followed winter and summer.

This plant had not been maintained in the best of condition. It was therefore necessary to give all the equipment a general overhauling, in the course of which the following changes were made, among others: Two new steam-operated vacuum pumps were installed, along with a new open feed-water heater, increasing the final temperature of the feed water leaving the heater from 180 deg. to 210 deg.

All excess piping was pulled out; the remaining

TABLE I—SUMMARY OF MONTHLY HEAT AND POWER COSTS, 1924

	Day Coal	Day Fireman	Supplies	Night Coal	Night Fireman	Watching	Total Cost	Kw.-Hr. for Month	Atmos. Mean Temperature
Jan.....	$916.94	$212.04	$55.72	$697 92	$212 04	$256.86	$2,351.52	39,581	29.8
Feb.....	882.87	198.36	51.07	617.35	198.36	240.29	2,188.30	34,842	24.9
March...	886.39	212.04	35.58	608.32	212.04	256.86	2,211.23	36,278	36.6
April....	786.30	205.20	31.95	442.73	205.20	248.57	1,919.95	34,067	47.3
May.....	731.32	212.04	47.06	419.25	212.04	256.86	1,878.57	34,527	55.6
June.....	658.75	205.20	51.78	364.25	205.20	248.57	1,733.75	32,713	66.2
July.....	623.87	212.04	34.36	391.37	212.04	256.86	1,730.54	33,118	72.6
Aug.....	582.73	212.04	38.45	388.98	212.04	256.86	1,691.10	32,459	71.4
Sept.....	618.06	205.20	26.13	397.22	205.20	248.57	1,700.38	32,627	60.6
Oct.....	658.75	212.04	28.50	379.75	212.04	256.86	1,747.94	34,111	53.1
						Pur. Power			
Nov.....	570.69	201.43	20.52	266.48	201.43	426.64	1,687.19	31,512	42.2
Dec.....	767.25	208.14	35.12	426.25	208.14	345.00	1,989.90	38,159	29.4
	$8,683.92	$2,495.77	$456.24	$5,399.87	$2,495.77	$2,527.16	$22,830.37	413,994	
						771.64			

Note—The total, $2,527.16, under column 7 is the cost of watching until the end of October, when the switch was made to purchased power and the watchman eliminated. The total $771.64 is the cost of purchased power for November and December.

TABLE II—SUMMARY OF MONTHLY HEAT AND POWER COSTS, 1925 (8 MONTHS)

	Day Coal	Day Fireman	Supplies	Night Coal	Night Fireman	Purchased Power	Total Cost	Kw.-Hr. for Month	Atmos. Mean Temperature
Jan.....	$806.00	$208.14	$39.87	$581.25	$208.14	$345.00	$2,188.40	40,049	24.4
Feb.....	620.00	188.00	47.09	356.50	188.00	345.00	1,744.59	33,755	35.6
March...	580.55	208.14	31.04	238.51	208.14	541.42	1,807.80	36,458	42.0
April....	489.58	201.43	18.80	66.74	201.43	713.92	1,689.90	33,363	49.4
May.....	304.86	70.86	8.13	48.03	203.71	835.86	1,471.45	32,402	57.0
June.....	.....	.....	3.19	.....	220.00	997.48	1,220.67	31,838	71.4
		Gas							
July.....		132.54	2.21	.....	220.00	915.86	1,270.61	31,226	71.3
Aug. ...	23.92	132.54	15.85	.....	220.00	932.94	1,325.15	28,473	70.7

[1]Several changes have taken place since this article was started. First the building was sold to the United States Security Trust Co. for a cash consideration of $2,375,000. Early in the present month the author became building superintendent, Fox Building, 16th and Market Sts., Philadelphia.

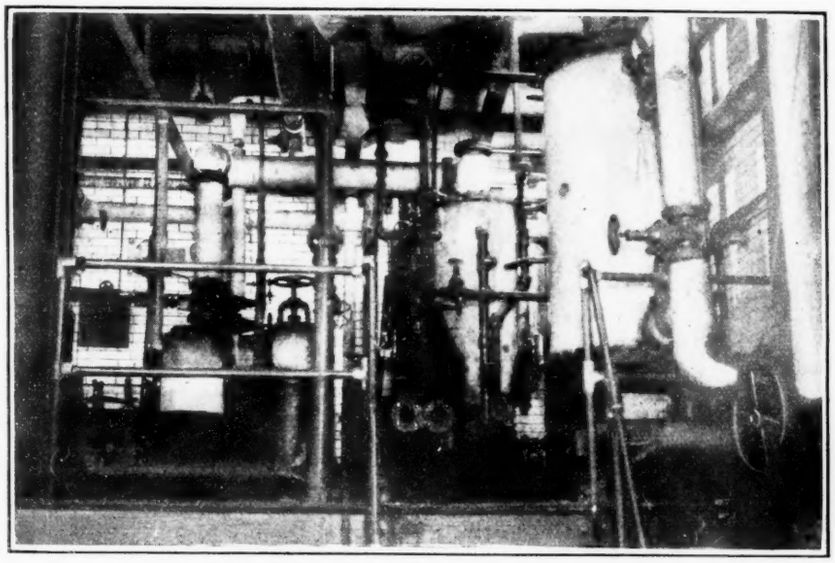


Fig. 1—Condition of pump platform in boiler room, July 1, 1923. To shift from one boiler feed pump to the other required the opening and closing of fourteen valves.

Fig. 2—This shows some of the unnecessary piping and fittings removed from the old pump platform

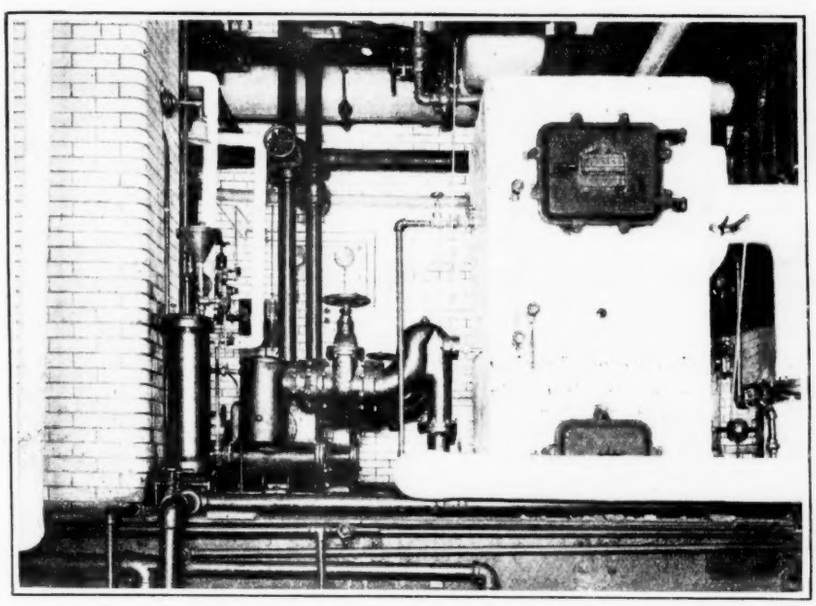


Fig. 3—Pump platform as it appeared Sept. 1, 1923, after installing new heater and simplifying the connections. Incidentally, the feed temperature was raised from 180 deg. to 210 deg.

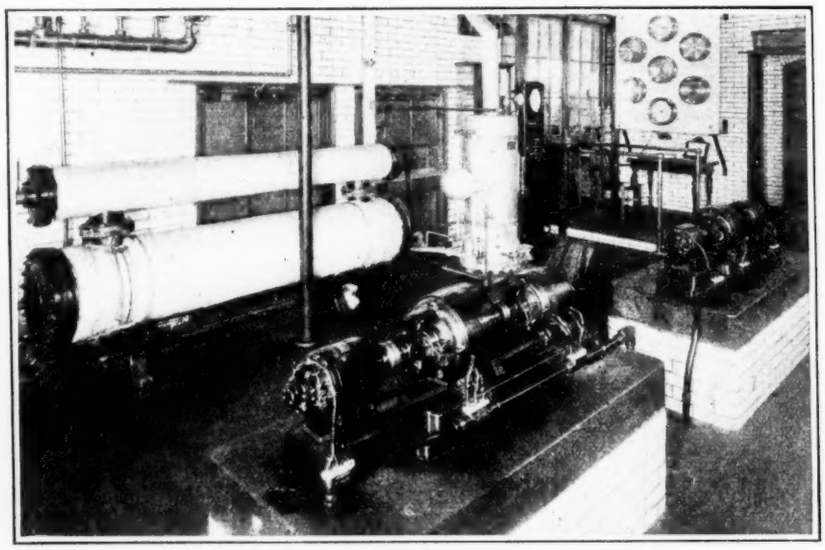


Fig. 4 — Corner of engine room, showing venturi meter, gas heater, gages, service hot-water tank and special generator sets for electric clock and bell service

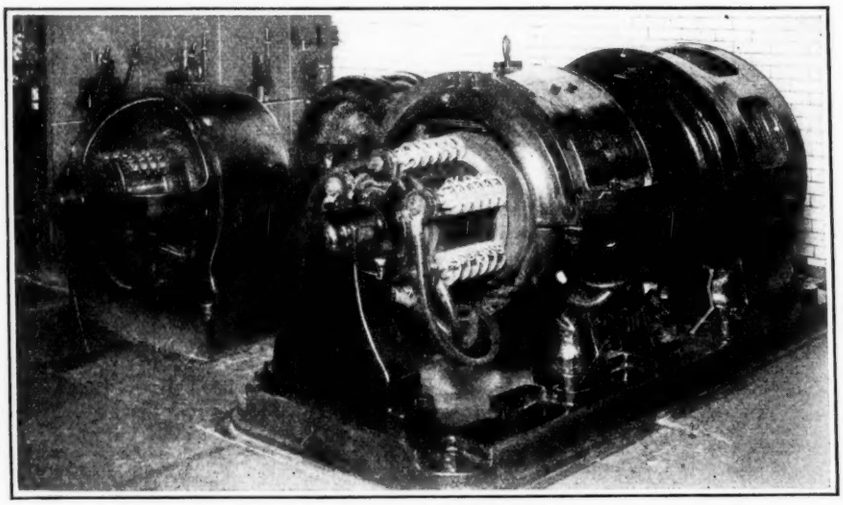


Fig. 5 (above)—Motor-generator sets supply enough power at all times to avoid waste of exhaust steam

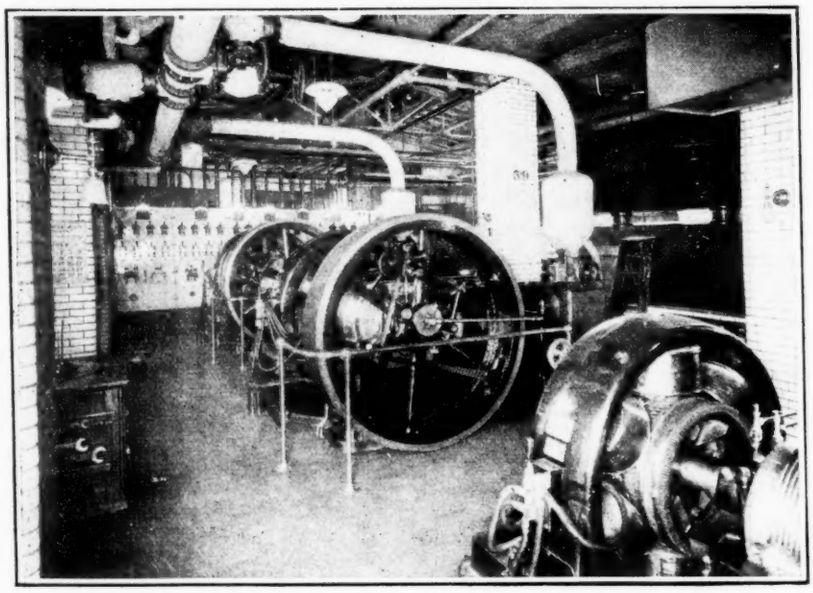


Fig. 6—Engine room, showing some of the generating sets and the switchboard

lines were straightened and provided with suitable drips connected to high-pressure return traps.

The brickwork on all three boilers was given a general resetting; grates were renewed where needed; dampers in the uptake were renewed and the main damper in the stack connected to a new and up-to-date damper regulator. All tubes and heating surfaces were cleaned.

After this overhauling of the plant was completed, a study was made of the data that were required to tabulate the operating cost. This resulted in the installation of a watt-hour meter for each generating unit and a venturi water meter of the indicating-integrating-recording type. A set of daily boiler-room and engine-room log sheets and a monthly summary log sheet was devised and put into routine use.

The statement was made to the central-station company at this time, that if at the end of one year the cost of operation of the plant exceeded the cost of a similar amount of power purchased from this company, ways and means would be discussed of effecting a change.

The log sheets used were very satisfactory from the viewpoint of the engineering data they carried, and it is believed that they would be well adapted for a study of operating cost in any similar plant. The information they contain is so clearly shown that it should bring home to any business man, even though he may have no understanding of the principles of engineering, the distribution of the money spent in operating a power plant of this kind.

A new set of elevators had been installed four years previous to this time at considerable expense, and furthermore, all the tenants of the offices, particularly doctors and dentists, had much money invested in direct-current electrical equipment. It was found to be inadvisable, therefore, to change from direct to alternating current.

At the end of five months the central-station company was called in to discuss the problem. As a result of the operating cost which had been conclusively determined, and the peculiar requirements of this plant, the local public-utility company established a new rate, even though there was no similar isolated

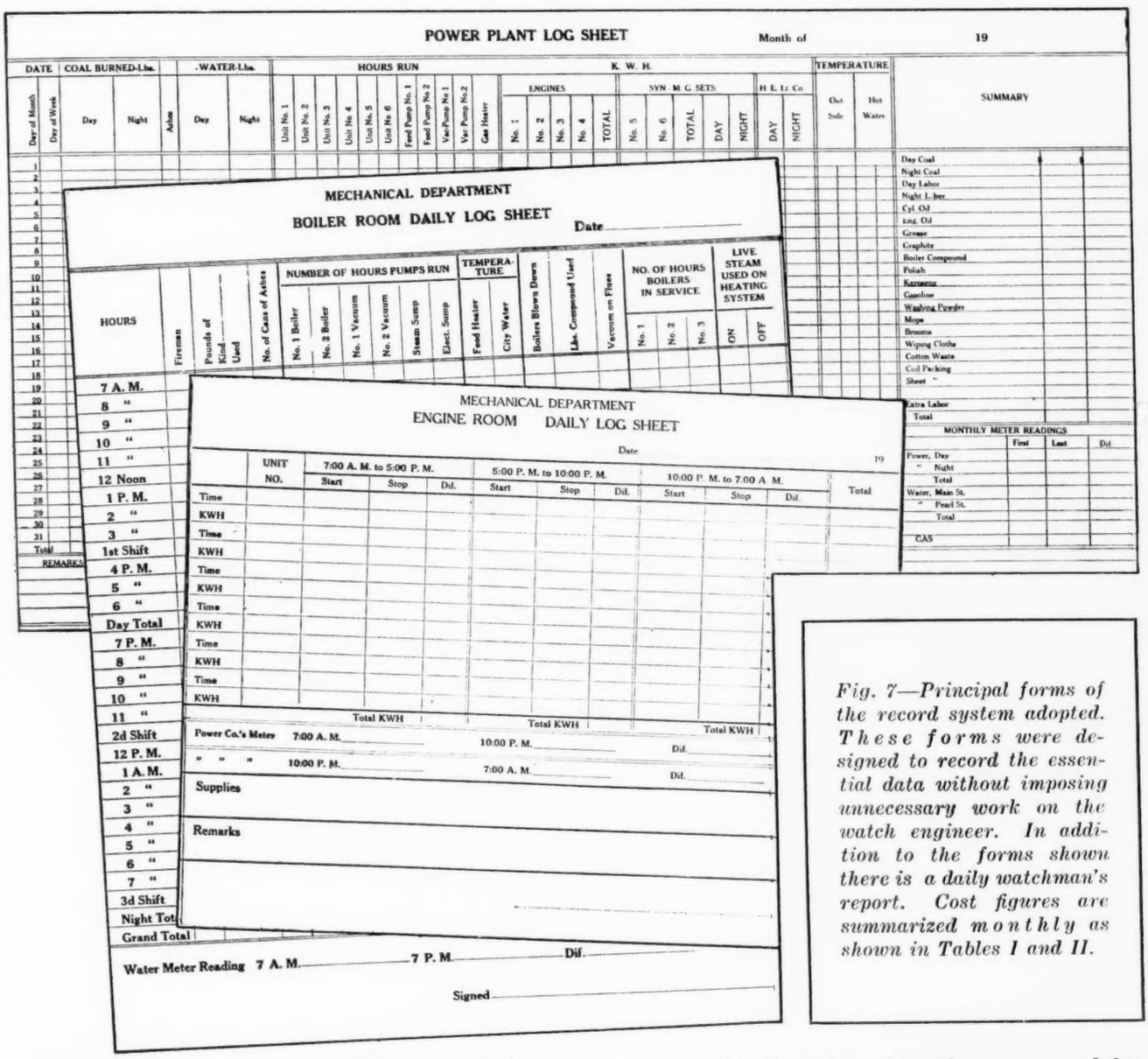


Fig. 7—Principal forms of the record system adopted. These forms were designed to record the essential data without imposing unnecessary work on the watch engineer. In addition to the forms shown there is a daily watchman's report. Cost figures are summarized monthly as shown in Tables I and II.

power plant in the community. A contract was drawn for supplying two-phase 60-cycle 2,400-volt alternating current as a reserve or auxiliary to the private generating plant.

Two motor-generator sets—one of 40 kw. and one of 140 kw.—were then installed, this work being completed in September, 1924. The plant was thereafter operated to a heat balance, the engine being used simply as a reducing valve. When the temperature of the building reached a satisfactory figure, it was found that a pressure of 2 lb. existed in the steam heating main, and at this time part of the electric load was shifted to the central station. As the building continued to warm up, the fires were banked, the engine was shut down and the entire load was shifted to the central power plant. At no time was any exhaust steam permitted to go to the atmosphere. One of the most interesting things noted was that only one boiler was needed to heat the building, this being run at its rated capacity and at times up to 25 per cent overload. The resulting increased boiler efficiency had a great deal to do with the saving of fuel over the old method of operation.

Under these conditions the saving shown over a period of seven months beginning Jan. 1, 1925, as compared to the corresponding seven months in 1924 under the previous method of operation, amounted to $3,011.

What To Do When the Pump Stops

Common Causes of the Failure of Direct-Acting Pumps— How to Put a Pump Back Into Service

By WILLIAM S. JONES

ALMOST every engineer sometime in his life has trouble with a steam-driven pump. Usually, the the difficulty is easily corrected once the source of failure is discovered, and frequently it is found that the machine is put out of service by the most insignificant misadjustment.

Inasmuch as all new pumps are thoroughly tested before leaving the factory, it is usually safe to assume that when a new pump either partly or completely fails to do the work for which it was intended the trouble is not in connection with the pump itself, but foreign to it. On the contrary, the pump that fails to work after a period of satisfactory performance, usually has some defect within itself, although there are many exceptions to this rule.

Improper Piping Causes Trouble

In enumerating some of the causes of new pumping machinery troubles, improper piping should be placed foremost. When installing a pump, particular attention should be given to the suction pipe. This should be of a uniform diameter throughout and all short bends should be avoided. The size of the pipe should be such that the fluid when passing through it, will not be excessively retarded by friction. As the friction is directly proportional to the area of the surface in contact with the fluid and nearly proportional to the square of its velociy, it is obvious then that excessive velocity means excessive friction. When pumping water, the velocity through the suction pipe should not exceed 200 ft. per min. and the rate of flow for fluids that are dense and viscous must be much less. Often, when a pump is being installed, second-hand pipe, of too small a diameter, is used, thus saving the expense of new material. This will prove to be poor economy, as the efficiency of the pump will be greatly impaired. More particularly is this true when the suction pipe is long, so that the friction head is easily built up to the point where it will retard the flow so much that the pump barrel will be only partly filled.

The vertical distance between the level of the supply and the pump should always be as low as circumstances will permit. When the suction pipe is long considerable time is required in exhausting the air from it when starting the pump, and if the lift be high it may be impossible to start the pump without priming, especially after the piston packing and the suction valves have become worn. When the liquid must be raised to a considerable height, much trouble will be avoided if proper arrangements are made for priming. The necessity for priming will also depend upon the relative volumes of the pump cylinder and the suction pipe and upon the amount of clearance space in the pump cylinder.

Proper Cylinder Clearance Important

If there is considerable pressure on the discharge valves, the matter of cylinder clearance becomes an important factor, as a pump having large clearance spaces might run an indefinite length of time without exhausting the air if the discharge valves are under considerable pressure. The air would be compressed but not discharged, and would re-expand on the next stroke, thus preventing the opening of the suction valves. Trouble of this kind might be overcome by drawing off the liquid standing in the discharge system, but it is not always convenient or desirable to do this, and it will not be necessary if arrangements have been made for priming. When the pump is required to start under the conditions just referred to, priming pipes as shown in *A* in Fig. 1, should connect the discharge system with each end of the pump cylinder. In this way the clearances can be filled with the liquid and the air will be discharged. The difficulty of having air trapped in the cylinder clearance spaces may be overcome by placing air cocks at each end of the cylinder, close up under the discharge-valve deck. When first starting the pump, these cocks should be opened during the discharge stroke and closed soon after the suction stroke begins, thus discharging the air trapped in the cylinder. An automotive air valve is preferable to an ordinary air cock. This is simply a spring-loaded valve opening outward and closing automatically during the suction stroke.

If there is a check valve in the discharge pipe, the priming pipe should connect with the pressure side of

the check valve; then the air in the clearance spaces of the cylinder can be completely expelled, provided there is a relief valve on the pump side of the check valve through which the air can escape. When the suction pipe is provided with a foot valve, the priming pipe can be connected directly to the suction pipe. The foot-valve will, however, make priming unnecessary unless the pump has been standing long enough to permit the liquid in the suction pipe to escape.

When a small quantity of liquid is on the discharge

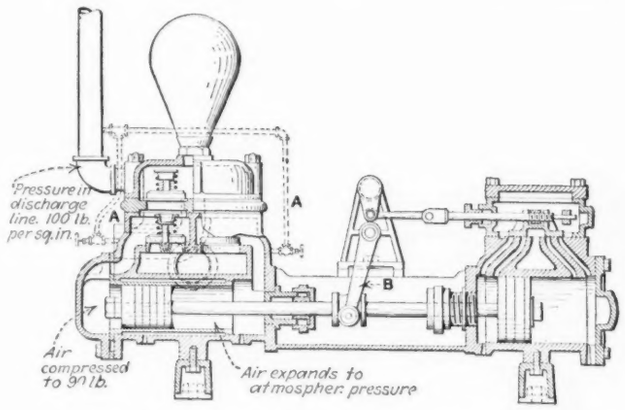


Fig. 1—Pump should have by-pass priming pump

valves, often a pump will start without resorting to the common method of priming. In fact, covering the discharge valves in this way is a common and most convenient substitute for priming. As the discharge valves lift, the liquid, in small quantities, falls through the valves into the cylinder, filling the clearances entirely or, at least, sealing the suction valves. The success of this method will depend somewhat on the location of the suction valves. When these are located below the cylinder bore, they will be sealed quickly and the pump may begin to work before the clearance spaces are filled, but when the valves are above the cylinder bore it may be necessary to fill the cylinder completely and considerable time will be required in starting, especially when the lift is high.

Most Troubles Are Caused by Simple Defects

When a pump completely fails to work, it is usually because of some simple defect, and as many engineers do not appreciate this fact, they are often unable to locate pump troubles. For example, a single direct-acting pump, having a capacity of about 600 gal. per min., was installed in a certain plant to handle salt water, but the engineer was unable to get the water end to work. There was no apparent cause for the trouble, as the lift was low and the piston packing and the valves were in good condition. It was important that the pump be in operation, and after much time had been wasted and many futile attempts to remedy the trouble made, the manufacturer was notified. The trouble man was met at the station by the irate owner of the plant, who at once proceeded to deliver a lecture calculated to convince the most incredulous that the pump in question was nothing more nor less than a mass of metal thrown together for the express purpose of causing trouble. On arrival at the plant the trouble man attached a vacuum gage to the suction pipe and showed at once that the trouble was not in connection with the pump itself, as the vacuum was high enough to cause the water to be forced considerably above the pump chamber. The suction pipe was removed and the foot valve examined. This valve was of the butterfly type, having two clack valves, and these had been fastened against their seats by wooden braces to prevent their becoming injured while being shipped as indicated in Fig. 2. The braces were still on the job, doing their work admirably, and were of course the cause of the trouble. Incidentally, this experience illustrates an important point; namely, that pump troubles are located frequently by the application of a little elementary knowledge of physical laws rather than by haphazard guesswork.

Troubles with direct-acting pumps can often be detected simply by using the eyes and ears. By placing the ear against the suction chamber, leaky suction valves can be detected as the liquid that is being forced back through these leaky valves will produce a hissing sound.

Watch the Action

Much can be ascertained by carefully observing the action of the pump. An abnormal action is always the effect of some misadjustment, although different causes may produce similar results. In one case a small direct-acting tank pump, having a low lift, failed to lift the water even after the pump had been primed. A vacuum gage was attached to the suction pipe, and the gage showed that the pressure in the pipe was equal to the pressure of the atmosphere. It was evident that the defect was in the pump cylinder, as a leaky suction pipe, unless the leak was very large, would simply mean a diminution of the vacuum in the suction pipe. The suction valves were examined, and it was found that these valves, which were of soft rubber, had adhered to their seats and considerable force was required to lift them. Valves that are placed in a pump in a dry condition are likely to adhere to their seats in this manner, and for this reason all suction valves should be examined before a new pump is started. Trouble of

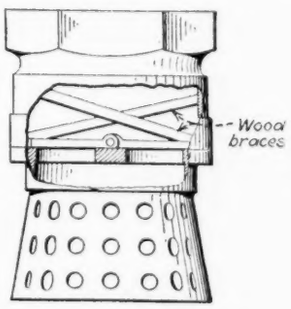


Fig. 2—Cleats held valve closed

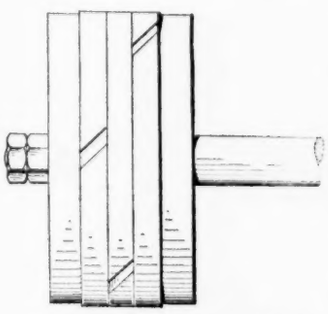


Fig. 3—Fibrous packing needs end clearance

this kind can be avoided by oiling the valves before placing them in the cylinder or by placing pieces of tissue paper between the valves and their seats.

The piston rods should be carefully packed and the glands should be screwed up just tight enough to prevent leakage. This is especially applicable to duplex pumps, as the friction of both pumps should be equalized as far as possible. When one pump rod is packed tighter than the other, the result is a quick stroke on one side, which will give an intermittent discharge and may cause the liquid to surge in the pipes.

When the pump piston is packed with a porous pack-

ing, the rings should be cut from ¼ to ½ in. shorter than the circumference of the cylinder, as the packing will absorb moisture from the liquid being pumped and will expand. If there is no room for expansion, the packing will be forced against the walls of the cylinder, causing the piston to stick. Provision should also be made for lateral expansion.

There are few troubles in connection with pump machinery that are more difficult to overcome than the one known as surging. This condition often exists in pump machinery having very long suction or delivery pipes. It may occur either in the suction pipes or in the delivery pipes, being, however, more severe in the latter.

Crank-and-flywheel pumps, owing to the variation in the piston speed between the beginning and end of the stroke, are particularly liable to cause surging, which is due entirely to an irregular delivery.

Duplex direct-acting pumps, owing to the uniformity of delivery and the absence of heavy weights such as flywheels, are not likely to cause surging, and when liquids must be moved through long mains, this pump is chosen. Crank-and-flywheel pumps forcing water through very high delivery pipes, as occurs in mine work, are seriously affected by the surging of the water, broken pump chambers, pipes, and damage to the working parts of the pump often occurring. Air chambers placed along the delivery pipe at intervals are employed occasionally as a remedy, the aim being to break up the vibrations of the surging water and get them out of step or out of harmony with the motion of the pump.

Surging in long suction pipes is likely to occur when the water flows to the pump by gravity. To prevent surging shocks reaching the machinery, a liberal-sized air chamber is needed in the suction main near the pump, and in addition spring-loaded relief valves may also be fitted to the main.

Pounding in pump cylinders is sometimes caused by the water lagging behind the plunger, due to the friction of the water in a small and long horizontal suction pipe. Suction pipes that have a long horizontal run should be larger than would otherwise be required.

Why Watch the Ammonia Gages if They Are Wrong?

By J. B. Stapleton

I received a telephone call one morning, asking that I get over to one of the refrigerating plants as soon as possible, as the engineer was having all kinds of trouble and thought he would have to shut down. On my arrival I was met by a very excited engineer, who informed me that the pressures in the ammonia system had equalized.

He claimed that things had not acted just right for fully a week, and finally he noticed that the head pressure gage was showing too low. The low-pressure gage registered 20 lb., which was about the usual pressure carried on the low side. Two days previous the high-pressure gage had shown 95 lb., or about 30 lb. lower than usual, and finally both gages were showing 20 lb.

The engineer insisted that he had been over the entire system and found all valves in the usual running position. According to his ideas there could be but one thing wrong—one of the bypass, or pump-out, valves was leaking.

A glimpse at the log sheet convinced me that there was no cause for alarm, as all temperatures were about as usual for normal running conditions.

After a few moments of thought I walked over to the compressor and opened up a little on the valve of the high-pressure gage line, which was usually carried well closed to eliminate excessive vibration of the gage pointer. The pressure returned to normal, or about 125 lb.

Another case, somewhat similar, occurred in a plant having two ammonia compressors with a separate gage for each machine. The gages were placed on the wall, with line connections to the discharge lines at each compressor. Ordinarily, both gages registered the head pressure regardless of which compressor was in operation. With either one of the machines in operation the head pressure usually stood at 165 lb., while with both of the machines running they would show 220 lb. The higher condenser pressure was due to the lack of condenser surface.

One day they shut down on account of high condenser pressure with only one machine in operation. The engineer called my attention to the gage of No. 2 machine, which registered 220 lb., remarking it was much too high. I glanced at the other gage and noted 105 lb.

Saying nothing, I started No. 1 machine, keeping an eye on the 105-lb. gage, which gradually climbed to 165 lb., or to about normal. No. 2 gage remained at 220 lb. until I opened the valve on the gage line, whereupon it fell back to 165 lb.

The engineer was speechless.

It seems that on the previous watch both machines had been in operation and on shutting one down, the gage-line valve had been closed and for three hours after coming on watch this gage had gone unnoticed by the engineer. When he did notice it, he became confused, lost his head completely and shut down the plant.

It is quite evident that regulations regarding ammonia gage lines are just as necessary and as important as those regarding boiler gage lines. I have made it a rule that no gage-line valve shall be cut so close as to eliminate all vibration of the pointer.

In another plant where pressures had equalized, the cause was somewhat different. Owing to boiler trouble it was necessary to shut down the ammonia compressors Saturday midnight. Monday morning, when ready to start up, the high- and low-pressure gages were both showing 15 lb. pressure. A few revolutions of the compressor convinced me that there was a shortage of ammonia in the system. Perhaps a leak had done its work while the crew labored in the boiler room.

All hands were sent on a search for leaks. It was found that after shutting down Saturday night, one of the engineers had decided that it would be a good time to do some purging, so he opened the valve on the purge tank and forgot it.

One of the established engineering assumptions, which has apparently been overthrown by experiments made by the Leather Belting Exchange Foundation, Cornell University, is that no power can be transmitted by a belt at speeds beyond which the computed centrifugal force equals the initial tension. The Exchange laboratory has transmitted power at speeds well beyond this supposed limit.

Locating Faults in Electric Elevators—Direct-Current Controllers—III

Faults in Full-Magnet Type Controllers That May Cause the Motor To Fail To Start, or Fail To Come up to Full Speed After It Does Start

BY CHARLES A. ARMSTRONG

ON A full-magnet type elevator controller the limit and safety switches are divided between the potential-switch and direction-switch coil circuits. Figs. 1 to 5 show some common arrangements of potential-switch and direction-switch circuits. Fig. 1 shows the potential-switch circuit for a drum-type elevator, and in addition to the other devices it has a slack-cable switch, which will be opened should the car or counterweights land on the bottom of the hatchway and the cables become slack.

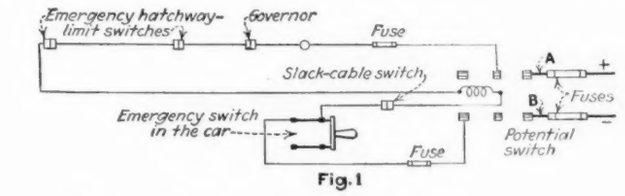


Fig. 1

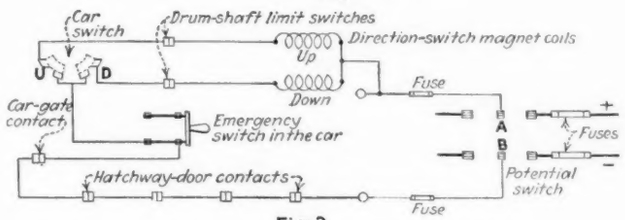


Fig. 2

Figs. 1 and 2—Potential- and direction-switch coil circuits on a drum-type elevator controller

On a traction-type machine the cables cannot become slack, so the slack-cable switch is replaced by a switch under the car, which is opened should the governor set the safeties on the car. In Fig. 3 the hatchway-limit switches are shown double-pole as in Fig. 8, while in Fig. 1 these switches are single-pole as in Fig. 9. These switches are mounted at the top and bottom of the hatchway and are opened by a cam on the car striking roller *R*.

On some drum-type installations both hatchway-limit switches in the potential-switch circuit are mounted at the bottom of the hatchway, so that one will be opened by the car and the other by the counterweights. The latter occurs if the car goes too far above the top landing. As has been discussed in the previous articles (Nov. 3 and Nov. 17), if any of the devices in the potential-switch coil circuit are not making proper contact, it will cause the potential switch not to hold closed. In all cases of trouble caused by the elevator's failing to start, the first thing to make sure is that the power circuit is complete up to the potential switch.

Too much emphasis cannot be laid on being sure that the power circuit is alive and complete to the controller, and the only sure test is that made with a lamp or voltmeter connected across the line. On a three-wire 110- and 220-volt circuit with grounded neutral, tests for power on the 220-volt circuit are sometimes made with a 110-volt lamp, connected one side to ground. That is, one side of the lamp is grounded and the other lead is connected first to one side of the circuit and then to the other. If a light is obtained on both tests, it is assumed that the power circuit is all right.

Experience has shown that such a test cannot always be relied upon. In one case in mind the line and potential switch for the elevator were mounted on a panel separate from the controller. This panel was mounted on the wall, which made it impossible to see the wiring. One day the potential switch on the elevator would not stay closed. A test was made of the power lines with a 110-volt lamp, one side of which was connected to ground. Since a light was obtained

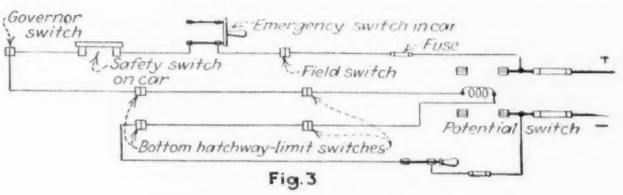


Fig. 3

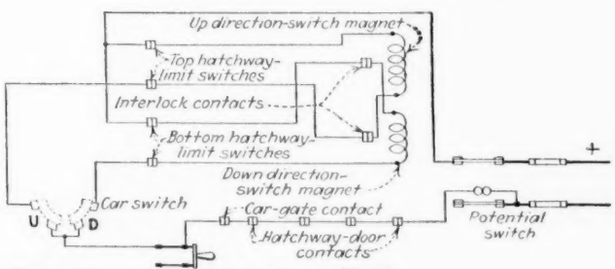


Fig. 4

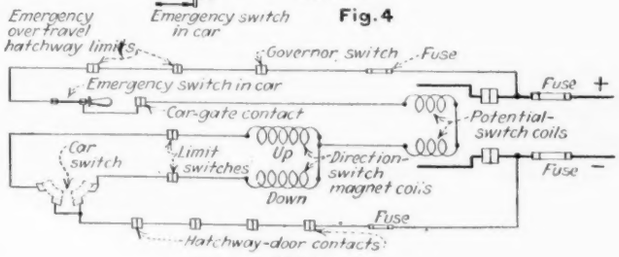


Fig. 5

Figs. 3 to 5—Potential- and direction-switch coil circuits on a traction-type elevator controller

on all four terminals of the fuses, it was assumed that the trouble was in the potential-switch coil circuit. This was tested through with the lamp and found to be complete, but when the potential switch was closed, the coil would not hold it closed.

Considerable search was made for the trouble when an attempt was made to start the elevator while holding the potential switch closed by hand. This revealed that the motor would not start and that the trouble was somewhere else than in the potential switch. The baffling part of the difficulty was that according to all tests made with the lamp to ground, the circuits were complete.

The mystery was solved by connecting the lamp across the load ends of the fuses. It was then found that the circuit was dead, although it tested all right to ground. Taking out the fuses and testing them showed one to be blown, and when replaced with a good

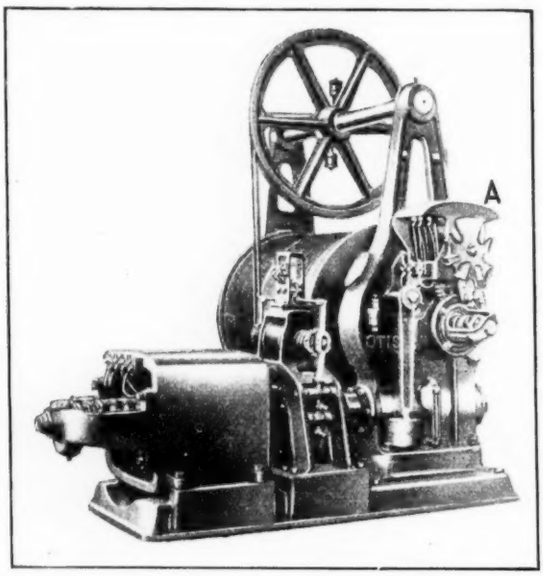


Fig. 6—Otis drum-type elevator machine

one, elevator service was restored. The reason why both ends of the fuses tested alive to ground was accounted for by finding that a pump motor switch, on the same panel with the elevator switch, was connected between the elevator circuit fuses and the potential switch, as at *A* and *B*, Fig. 1.

After it has been ascertained that conditions in the power circuit are correct for operating the elevator, as indicated by the potential switch remaining closed and the motor failing to start when the control switch in the car is put in the on position, then attention should be given to the direction-switch circuits. There are two conditions that will generally be met with in a full-magnetic type controller, that is, a controller operated by a car switch: One, when the car switch is placed in the on position, the direction switch on the controller closes, and two, when the direction switch fails to close.

From either one of these conditions a fair idea may be formed as to where the trouble may be. If the direction switch responds to the control switch in the car, it is known that this circuit is not only alive but is in operating condition. Since the direction switch closes and the motor does not start, it would indicate that the trouble is in the motor circuit itself. If the motor will not start with either one of the direction switches closed, it is a pretty sure indication that the trouble is not in the direction switches, but in other parts of the motor circuit. It is possible that the circuit could be open in one switch, but the motor circuit in both switches being open at the same time seldom occurs, therefore if the motor fails to start with either

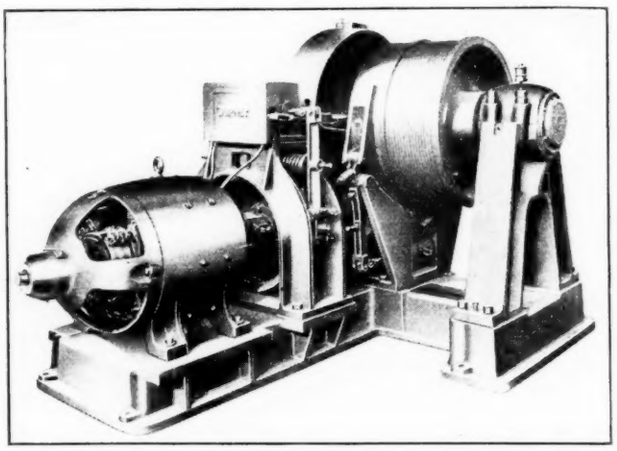
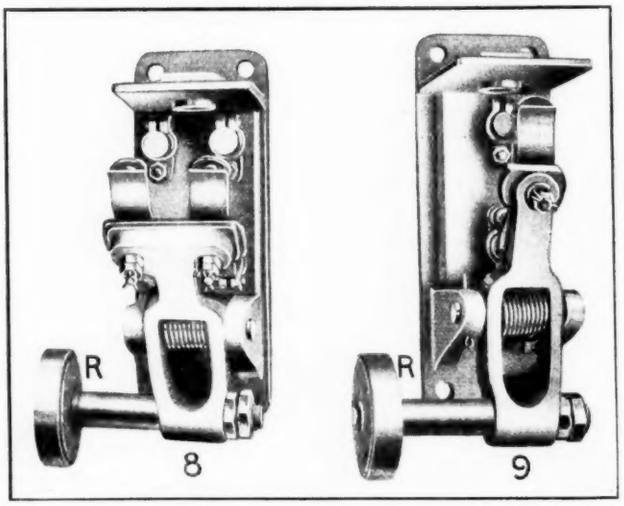


Fig. 7—Gurney heavy-duty traction elevator machine

reverse switch closed, the possibilities of the trouble being in these switches is remote.

Having eliminated the direction switches as being the source of trouble, the most likely places are in the motor or in the starting resistance. The starting resistance may be tested by connecting a lamp in series with the armature and closing all the accelerating switches; this will cut all the resistance out of circuit, and if the trouble is in this part of the circuit the



Figs. 8 and 9—Double-pole and single-pole hatchway-limit switches

lamp will light. These tests were described more fully in the article in the Nov. 17 issue.

If the direction switches fail to close, it is an indication that their coil circuits are not complete. Fig. 2 shows the direction-switch circuits for a drum-type machine. Starting at *A* on the potential switch, the circuit is through a fuse on the control board, then

through either the up- or down-motion direction-switch magnet coil, depending on the position of the car switch. From the direction-switch magnet coils the circuit continues through the drum-shaft limit switches, the car switch, one side of the emergency switch in the car,

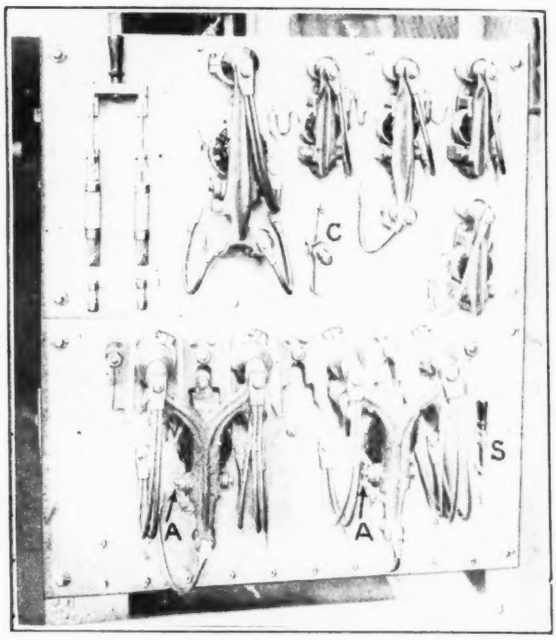


Fig. 10—Gurney single-speed full-magnet direct-current elevator control panel

car-gate contact and the hatchway-door contacts to the negative side of the line.

Any of these devices not making contact will prevent the direction switches from closing. It is possible that one switch will close and the other will not, at other location than the terminal landings. For example, if the circuit on the down-direction switch coil is interrupted between the coil and the car switch, this switch will not close when the car switch is in the down position, but this would not interfere with the circuit of the up-direction switch coil. On the other hand, if the open is between the car switch and the — side of the line, it will interrupt the circuit of both direction-switch coils and neither will respond to the car switch. These two conditions give an idea whether the trouble is in the individual coil circuit or in that part of the circuit that is common to both coils.

If neither one of the direction switches will respond to the car switch, a test can be made to determine if the trouble is in the direction-switch coil circuit or in the power circuit, by closing one of the direction switches by hand. With the power circuit complete the motor should start when the direction switch is closed by hand, or at least an arc should be obtained at the contacts when the switch is allowed to open. The absence of these indications would show that power was not getting to the controller.

When closing either of the direction switches by hand, care must be exercised to be sure that it is safe to move the car and also not to run the car by the terminal landings, since, unless the equipment is protected with emergency limits and a potential switch, there is danger of pulling the car or counterweights on a drum-type machine, into the overhead work with disastrous results.

On some types of controllers an operating switch is provided on the control board for operating the car from this point. Such an arrangement is shown in Fig. 10. When the single-pole knife switch *S* is in the up position, as shown in the figure, the car can be operated from the car switch only. Throwing switch *S* to the down position allows operating the car from the control switch *C*. This switch is generally connected in the circuit so as to cut out all safety switches in the circuit with the exception of the terminal floor limits, and can operate the car on the first speed only. If the car will operate from the control-board switch and will not from the car switch, it shows that the trouble is in the part of the circuit not included in the circuit of the former. This information would assist in narrowing down the number of places to look for the trouble.

Assume a case where there is no operating switch on the control board and the motor will start when the direction switches are closed by hand, but neither of these switches will respond to the car switch. One of the first things to do is to examine all the contacts in the car-switch circuit. These will vary with the type of installation and the locality. In Figs. 2 and 4 gate and door contacts are shown. On many installations these are not used, but when they are, they should be

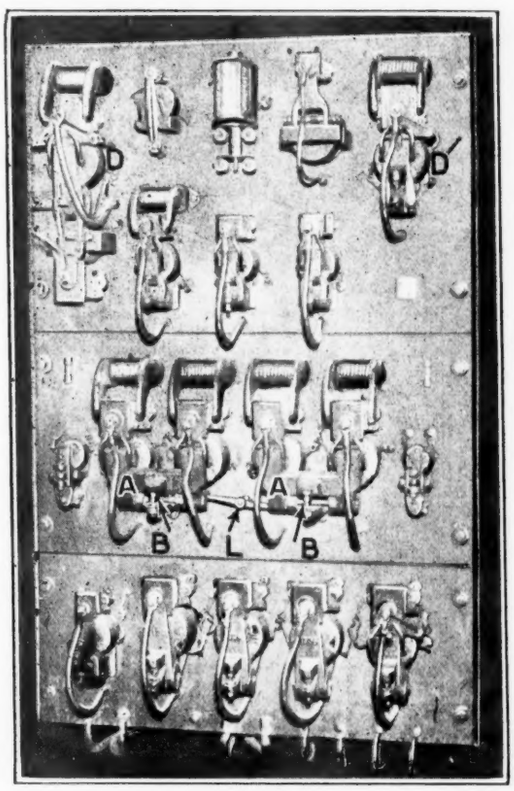


Fig. 11—Payne three-speed direct-current control panel

one of the first sources of the trouble looked into. On cars provided with an emergency switch for short-circuiting the door contacts, the test for the trouble in these contacts can be made by closing this switch. If the car can be operated with the door contacts out of circuit and not when they are in, some of these contacts are out of order.

Unless the car switch is given careful attention, the contacts may become worn or out of adjustment and

fail to complete the circuit. If the trouble cannot be found in any of the limit and safety switches, attention should be given to the wiring. If there is a fuse in this circuit, it should be one of the first things tested. Owing to the bending of the traveling cable, which makes the connections between the hatchway wall and the car, it is always a potential source of trouble. When the trouble is in the traveling cable, it is likely to disappear temporarily if the car is moved by closing the direction switches on the control board by hand. Where trouble of this kind is being experienced, the traveling cable should be renewed, as locating the open-circuit in this cable and repairing it, generally gives only temporary relief.

Direction switches are generally equipped with an interlock so that one switch must be open before the other can close. Where this interlock is electrical, it consists of contacts on the switches through which the coil circuits are made. The contact for the down-direction switch coil is closed when the up switch is open and vice versa. These contacts are indicated on Fig. 4. On such switches unless the interlock contact on one switch completes the circuit, the other switch cannot be closed from the car switch. A mechanical type of interlock is shown at *L*, Fig. 11, and consists of a bar fulcrumed in the center so that when one switch closes, it holds the other open.

On some types of controllers it is possible for the direction switch to get out of adjustment so that the magnet coils cannot close them. Direction switches of

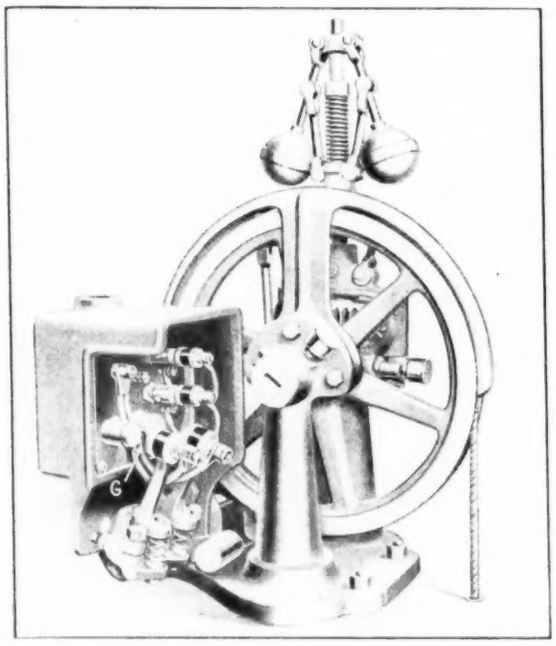


Fig. 12—Governor with safety switches

this type are shown in Fig. 11, and the adjustment is by a screw at *B*. The closer the armature *A* is brought to the magnet core the greater the pull that will be developed for closing the switch. On this controller there are two coils on each direction switch. There are also two potential switches *D* and *D'*. As shown in Fig. 5, all four coils are in series. On this controller the potential switches open and close with the direction switches, and anything preventing one from closing will prevent the other, with the exception of a short-circuit in one of the coils. For example, a short-circuit of coil *D* would prevent this switch from closing, but the other potential switch and one of the direction switches will close, depending on the position of the car switch.

On some types of controllers, using horizontal solenoids for closing the reversing switches, the movable core has been known to wear into the brass sleeve of

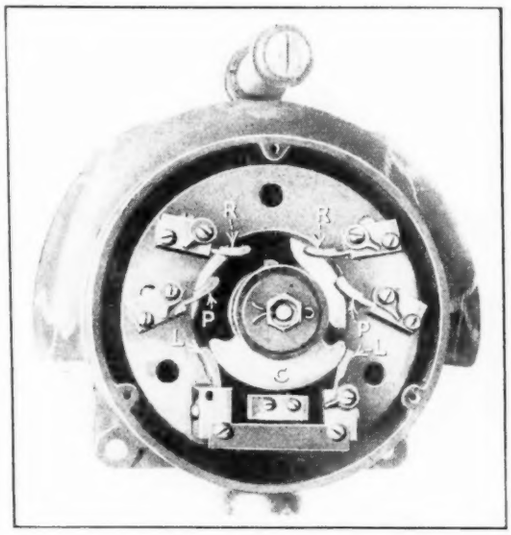


Fig. 13—Two-speed car switch

the coil to such an extent as to prevent the switch from closing properly. On such switches dirt is liable to gum up the core and sleeve and prevent the switch from returning to the off position to close the interlock contacts, thus causing unsatisfactory operation of the elevator. In other cases the contactors are made sluggish in their operation by the lack of lubrication on the bearings that support the contactor arm, such as those shown at *A*, Fig. 10. A little lubrication on the bearing during the regular inspections will insure satisfactory operation of the contactors. Grounds in the wiring or short-circuits in the direction-switch coils will cause the fuses to open in these circuits and prevent operation of the switches.

In some installations one or more switches are on the governor, such as shown at *G*, Fig. 12; in other cases such switches may be omitted.

Direct-current elevator controllers are designed for a wide variety of speeds. For the slow-speed machines only one speed is used, in which case there would not be over four contacts on the car switch such as *L* and *P*, Fig. 13. On a two-speed controller there are six contacts, as in Fig. 13, the two top contactors giving the second speed. For high-speed machines as many as six different speeds may be obtained, in which case the car switch may have as many as 14 contacts. However, in any case the first two contacts to make, in either direction, when the car switch is moved to the on position, is the direction-switch circuit.

On machines that operate at more than one speed the cause of the machine's failing to come up to full speed after starting will depend upon the type and make of controller, and a careful study of high-speed elevator control circuits is to be recommended. However, if the various contactors on the controller and the car switch and limit switches are kept in good condition, about 90 per cent of the cause of trouble will be eliminated.

How To Pipe a Cooling Water System for an Oil Engine

By Edgar J. Kates*

EXCEPT in the rather rare cases where water can be taken directly from city mains and then run to waste, the cooling water used in oil-engine jackets is delivered to the engine by a pump on the premises. Unfortunately, in many plants the pump and pipe arrangements are faulty.

The simplest possible form of pumping system is shown in Fig. 1. The pump draws its supply from a pond or river and forces the water directly through the engine. There is no overhead tank for the water

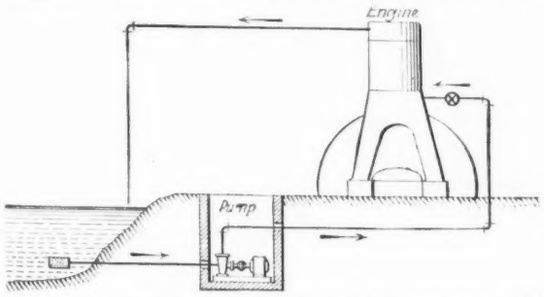


Fig. 1—A common type of cooling system, which should not be used

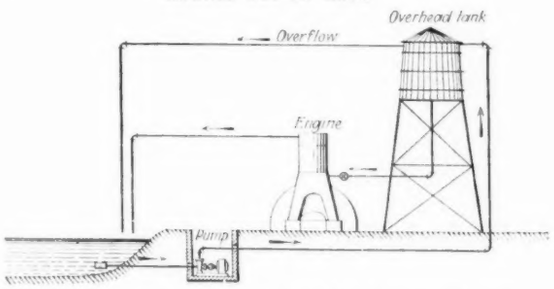


Fig. 3—A system coming into general use

outlets. The simplicity of this system is beyond contradiction, but the absence of an overhead tank and discharge funnels is a grave fault.

The lack of an overhead tank results in there being no reserve of water to take care of emergencies. If the pump should stop working for any reason, the water circulation through the engine would stop immediately and the water would soon boil in the jackets. If the pump is driven directly off the engine, no water is available until after the engine has started up, and after the engine has been shut down, no water can be circulated through it for the purpose of cooling it off. It is quite important to have water available for both these purposes.

When no overhead tank is used, whatever air is accumulated in the water through bubbles at the suction inlet or through leakage at the pump stuffing box, goes to the engine and forms air pockets in the water jackets, which prevent proper cooling.

All these troubles are easily overcome by adding to the system an overhead tank. One's first thought in installing such a tank would be to achieve economy in piping by using a common inlet and outlet pipe as shown in Fig. 2. In other words, the overhead tank would be floating on the line and would receive only the surplus water not required by the engine.

The piping system shown in Fig. 2 is, however, undesirable. In the first place, air entrapped in the water can still be delivered into the engine and form air pockets. When the pump is stopped, either by accident or on purpose, some of the water may run back from the overhead tank through the pump instead of being used to keep the engine cool. In the third place, with this system the discharge head on the pump is not constant, and if the pump is a centrifugal, the variable head will cause large changes in the amount of water pumped. The various faults just described do not exist when the overhead tank is piped up with a separate inlet and outlet as shown in Fig. 3.

This system takes care of supplying the water to

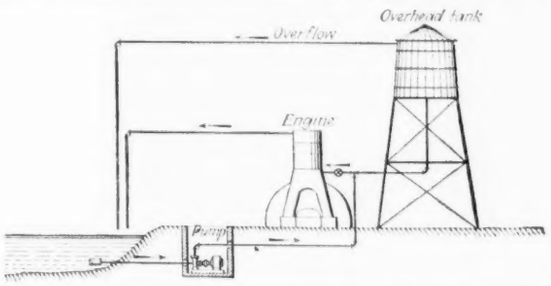


Fig. 2—This is an improvement, but air pockets may form

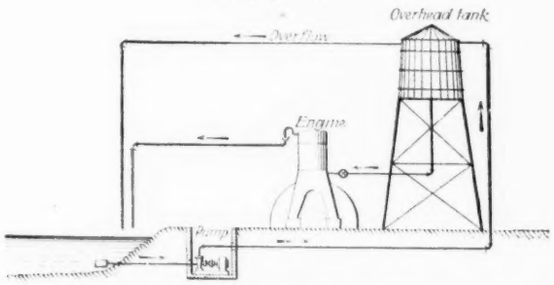


Fig. 4—This system has visible outlets at the engine

the engine, but does not take care of the water outlet which is carried by closed piping. Consequently, there would be no indication of water failure if the pump should stop and the tank run dry, or if the engineer forgot to open the valve in the line leading to the engine, causing the water to boil in the jackets.

In Fig. 4, funnels are used to show the rate of flow and to vent steam as a warning in case of overheating. This is the simplest *reliable* piping system that can be used where the water has to be pumped.

When installing an engine do not place the water-control valve on the *outlet* side of the engine. If someone forgets to open this valve before starting up the engine, there will of course be no circulation, the water will boil in the engine jackets and the steam formed will back the water out of the jackets into the inlet pipe, and the engine may be seriously damaged by overheating before the trouble is discovered.

One should never use a centrifugal pump driven directly off the engine if the engine must occasionally run at reduced speed. The delivery of centrifugal pumps falls off greatly as the speed is reduced and the pump may not deliver any water at all. For reduced speed operation use a reciprocating pump and make it at least 20 per cent larger than the size recommended for constant speed operation.

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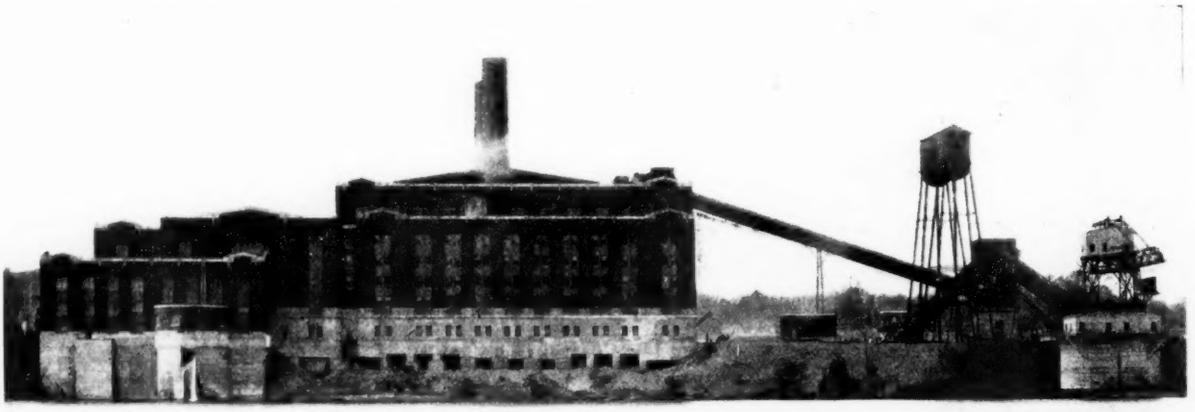
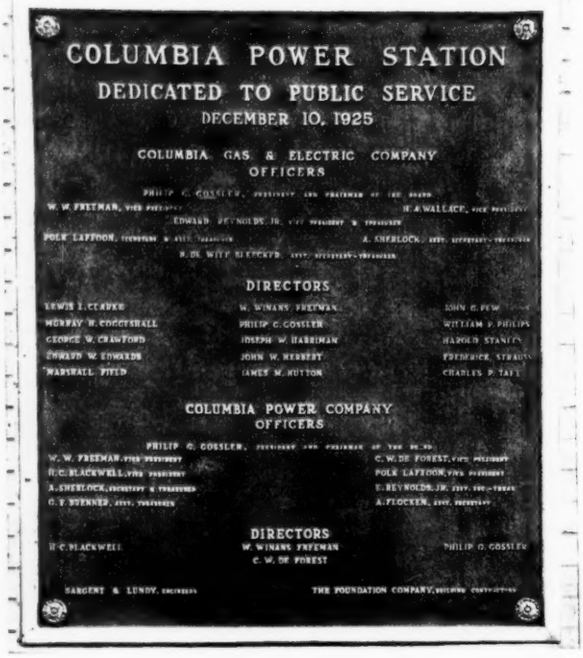


The Columbia station as seen from the river



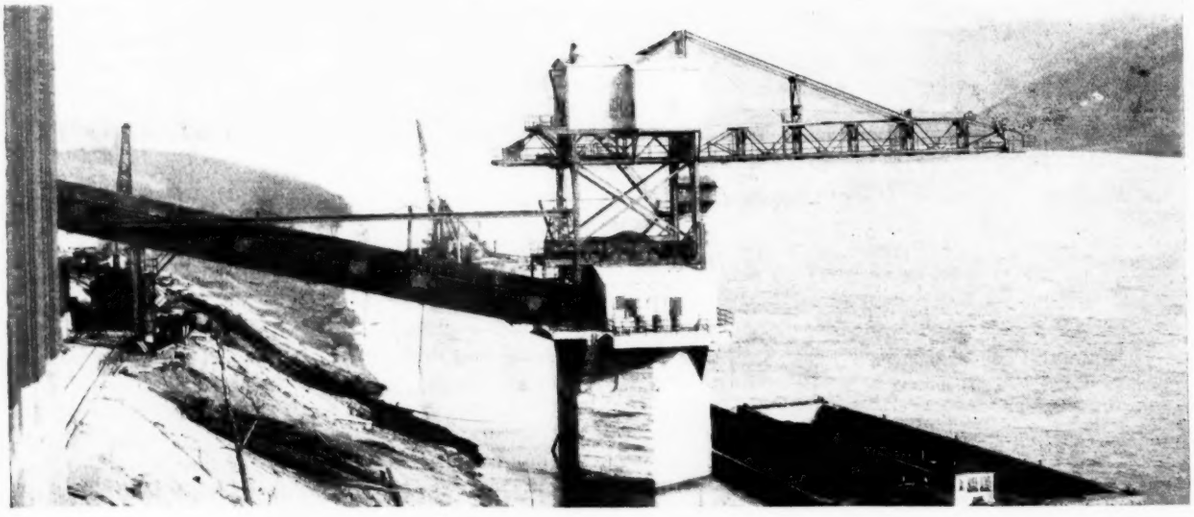
Tablet placed on wall of turbine room to commemorate the occasion

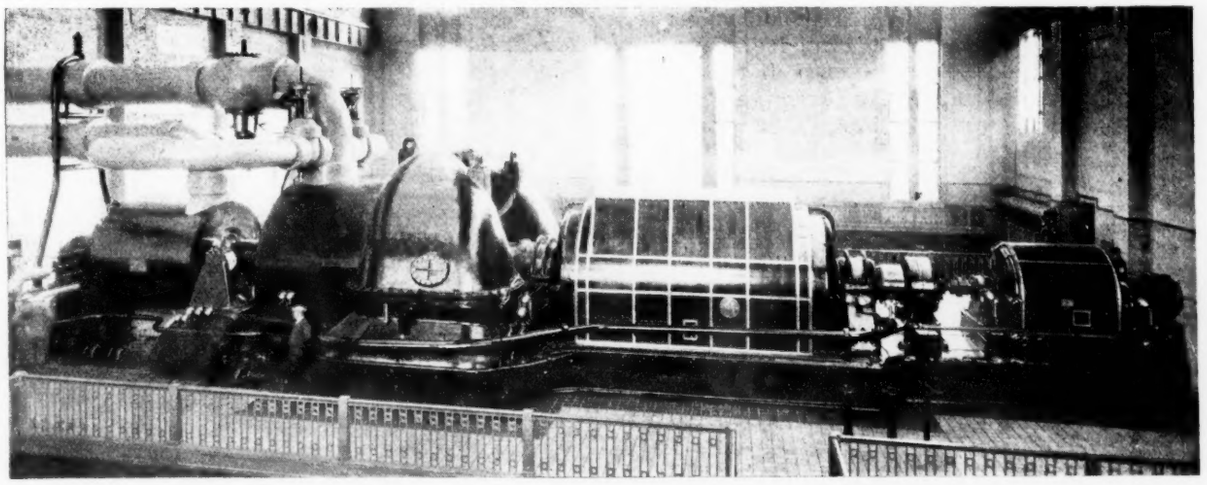
Columbia Power Station

of the Columbia Power Co. at Cincinnati, O.

Over twenty thousand people visited the new station during the four days following the dedication on Dec. 10, an account of which appeared in last week's issue of *Power*.

Coal is hoisted from barges and delivered to an inclined conveyor. After passing through a crusher it is conveyed to the station or delivered to storage to be reclaimed by a drag bucket

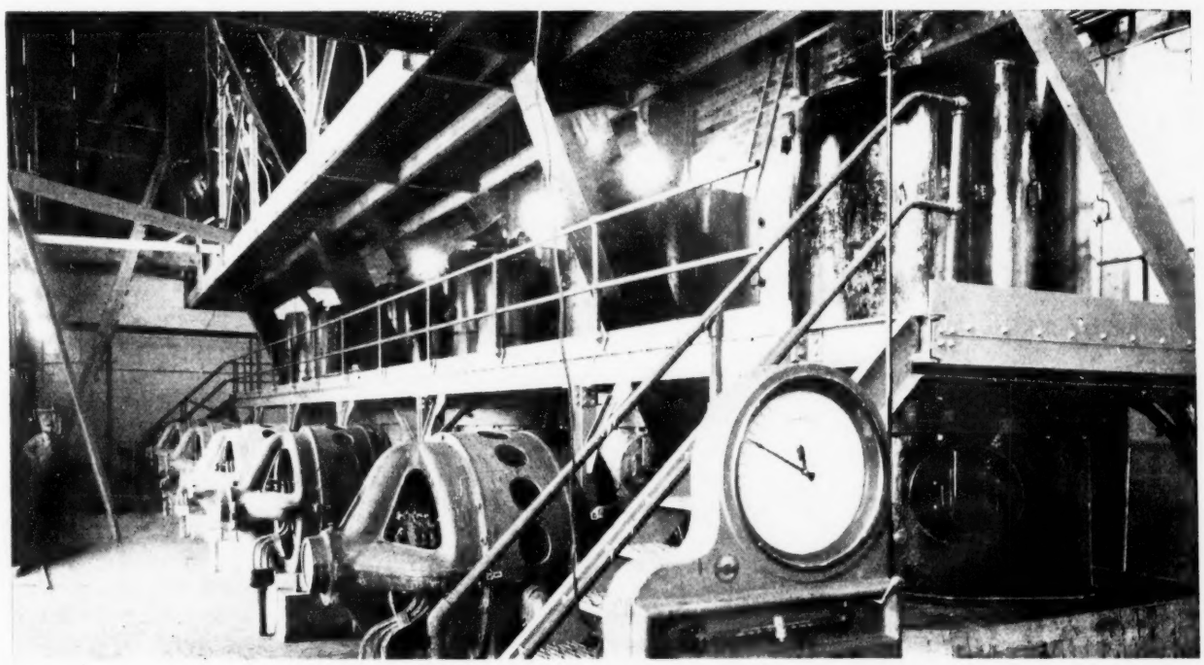




One of the two 45,000-kw. turbo-generators. Note the arrangement of piping for reheating between the high-and low-pressure sections

Miss Junggren, daughter of the turbine designer, opens the throttle

View of pulverizing mills. Each is of 8½ tons capacity



Hydraulic Turbine Governing—General Principles

By S. LOGAN KERR
Assistant Hydraulic Engineer, William Cramp & Sons Ship & Engine Building Company

WHEN it is considered that the penstock leading to a hydraulic turbine may contain millions of pounds of water moving at a rate of 10 or 12 ft. per second and that the operating mechanism to control this water to the turbine may weigh many tons, it is evident that the proper governing of a hydraulic turbine is by no means a simple problem. In this article, which is the first of a number, the author outlines the characteristics that a good governor must possess, how these are incorporated in the governor, and shows what takes place in the various parts of the hydraulic system when full load or half load is taken off the unit.

MAINTAINING the speed of the unit as nearly constant as possible is the principal function of a hydraulic-turbine governor. The ability or inability to accomplish this function is usually considered a measure of the performance of the governor in question, oftentimes with little regard to the conditions under which it is required to operate. For alternating-current generators, constant frequency is of prime importance, and special care must be exercised to prevent or to reduce any excessive variation in speed which might occur on the various prime movers operating in parallel with the system.

In modern hydro-electric power stations the governor is called upon to perform satisfactorily under a variety of different conditions. With the turbine operating without load, the governor should hold the speed sufficiently steady to permit rapid synchronizing with the system or with other units in the same station. Under load the governor should operate satisfactorily in parallel with the other generating units, sharing the load demand equally or not as desired, without unnecessary interchange of load between units.

The governor should hold the speed constant with a steady load and act to compensate for any variations occurring in the load demand which cause changes in frequency. Under emergency conditions, such as usually occur in power stations, comprising short-circuits, lightning disturbances or sudden loss of load, the governor should act promptly without danger of losing control of the unit, without excessive variation in speed beyond the inherent limitations of the installation, and should return the speed of the unit to normal without delay. Finally, the governor must be provided with manual controls as a means of adjustment of load or frequency when desired by the operator.

Essential Characteristics

To meet these various requirements, the governor must be designed to have three principal characteristics —sensitiveness, stability, and correct primary and secondary compensation. A study of governor problems suggests the definition of each of these characteristics with a view to segregating their essential differences.

1. Sensitiveness in a governor is the degree of speed change required to cause the turbine gates to move in response to changes in load on the main unit.

2. Stability may be defined as the ability of the governor to avoid unnecessary movement of the turbine gates, when the speed change of the unit is less than the degree of sensitiveness of the governor.

3. Compensation is divided into two classifications, primary and secondary, and serves in a measure to anticipate and to provide for the hydraulic phenomenon and energy change that follow the governor movement. Primary compensation is the action of the governor to correct the movement of the gates in response to a load change. With the initial movement of the governor the gates are opened or closed as the case may be, and the first compensation is to retard or stop this movement, thus preventing unnecessary overtravel. Secondary compensation is the subsequent action of the governor which modifies the first compensation and acts to adjust the gate setting to correspond as nearly as possible with the final position to be assumed after the load change is over.

For example, in Fig. 5, which is a diagram of a typical governor system, assume a rejection of load on the turbine. This will result in an increase in speed which will cause the flyballs to separate and in so doing raise the right-hand end of lever *L*. Movement of lever *L* actuates the governor valve to admit pressure oil into the right-hand end of the operating cylinder and release fluid from the left-hand end into the sump tank. This causes the piston to start moving to the left and closing the turbine gates. When the piston in the operating cylinder begins to move to the left, the primary compensation comes into action through the bell crank pivoted at *P*, and raises the left-hand ends of levers *L'* and *L*. This motion compresses the spring in the spring case of the secondary compensation and also lowers the right-hand end of lever *L*. The operation of the primary compensation started the op-

erating valve moving toward the neutral position. While this is taking place, the spring on the secondary compensation is coming into action and is raising the plunger in the dashpot and lowering the left-hand ends of levers L and L', thus tending to hold the governor valve open. The result of the combined actions is to adjust the gate setting to correspond with the final position after the load change is over.

The proper co-ordination in the governor of the three characteristics previously mentioned, when coupled with mechanical correctness, should result in the proper functioning of the governor, subject to the inherent limitations, hydraulics, dynamic and electrical, of the installation.

The sensitiveness and the stability of the governor are closely related, for a governor can be made so sensitive that it loses its stability, or so stable that it would impair the proper response to speed changes.

To provide maximum sensitiveness without loss of stability, the governor should act to correct a load change when the speed varies one-quarter to one-half of one per cent from normal. This standard insures freedom from continual hunting following slight changes in load, and for practically all power systems results in maintaining the frequency on relatively steady loads within the limits of good commercial practice.

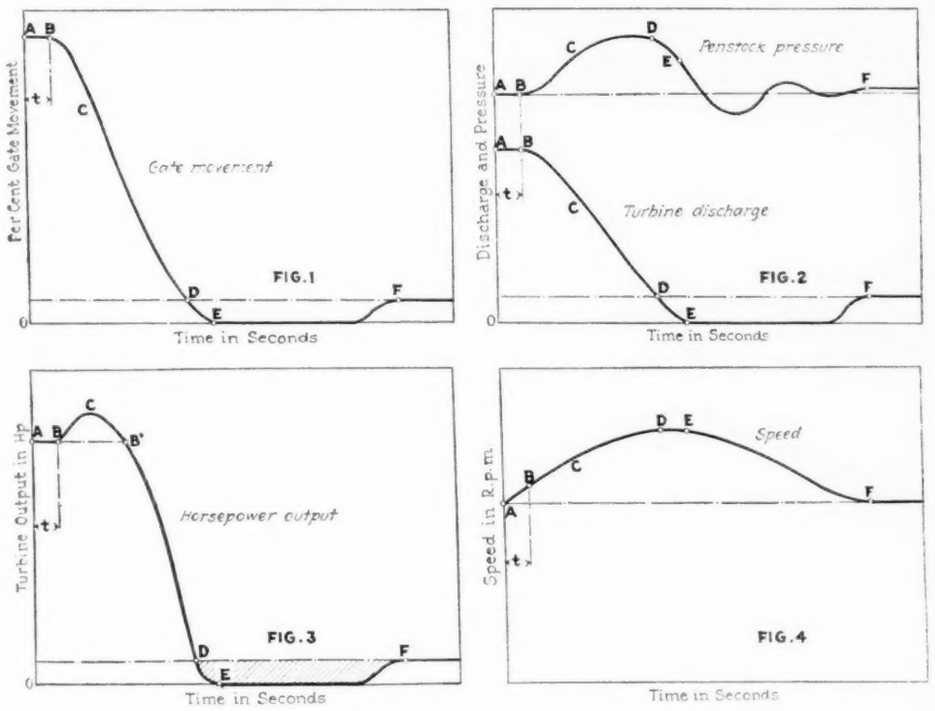
In certain unusual cases where a far closer degree of regulation is required than is the usual commercial practice, the sensitiveness of the governor can be increased somewhat so that the percentage of variation from normal required for the governor to act is as low as one-eighth of one per cent. In order to secure this condition the stability of the governor must be sacrificed to some extent, and the exceedingly careful adjustment of the compensating devices is essential, with a resultant increase in both first cost and maintenance. This is very rarely found necessary and forms a special case, rather than general practice.

With a change in load on the unit there is an excess or deficiency in power output over or under the demand, resulting in a change in energy of the rotating parts of the generator and turbine supplemented by the available flywheel effect of the connected system. The subsequent increase or decrease in speed of the unit is followed by a corresponding change in the position of the flyballs of the governor; the pilot valve then acts and pressure is admitted through the regulating valve to the turbine operating cylinders. As soon as this change in speed exceeds the degree of sensitiveness of the governor, the gates tend to move to a new position more nearly corresponding to the changed load on the unit. It can therefore be seen that the full governor action can begin only when the speed change is in excess of the degree of sensitiveness of the governor.

Dead Time of the Governor

The time required for the acceleration or deceleration of the rotating element of the unit to equal the degree of sensitiveness of the governor added to the time thereafter for the gates to start their movement, is called the dead time of the governor. In other words, the time that elapses between the rejection or application of load and the first movement of the gates is the dead time of the governor. With the degree of sensitiveness of the governor fixed by practical consideration, the dead time is subect to the total flywheel effect on the system and the response of the gates to movements of the flyballs. This latter element is really a part of the sensitiveness of the governor and leaves therefore only the flywheel effect, which can vary the dead time.

With a single isolated unit the flywheel effect is relatively small, which causes the dead time to reach its minimum value, usually less than one-half second for modern governors. On large systems the flywheel effect of the generating units is increased by the flywheel effect of the connected load, and the total may be sufficiently great to keep the speed variation for small load changes from exceeding the range fixed by the



Figs. 1 to 4—Show graphically what takes place when a full load is suddenly removed from a hydraulic turbine

When the load is thrown off, the turbine gates do not immediately start to close, but a certain period must elapse to allow the unit to increase in speed to a value where the governor will open the pilot valve and build up a pressure in the gate-operating cylinders to overcome the various forces that tend to keep the gate mechanism at rest. When the gates start to close, at B, Fig. 1, they retard the flow in the penstock and cause a pressure rise, which may for a short period result in an increase in power to the turbine, as indicated from B to B', Fig. 2, and the speed keeps increasing. At D the gates are close to the no-load position, but the speed is so far above normal that the governor moves them to the full-closed position at E, where they remain for a considerable period until the speed drops to near normal, when they open to the no-load position. The time from A to B may be less than one-half second, from B to E about three seconds and from E to F from 4 to 14 seconds.

sensitiveness of the governor, and hence results only in an increase or a decrease in speed on the system so small that no governor action is necessary. In other words, the load change is absorbed by the system.

The foregoing condition has given rise to the suggestion that governors be omitted from small units operating in parallel with large systems where the usual changes in load form a small part of the total load carried. The provision for larger load changes is made

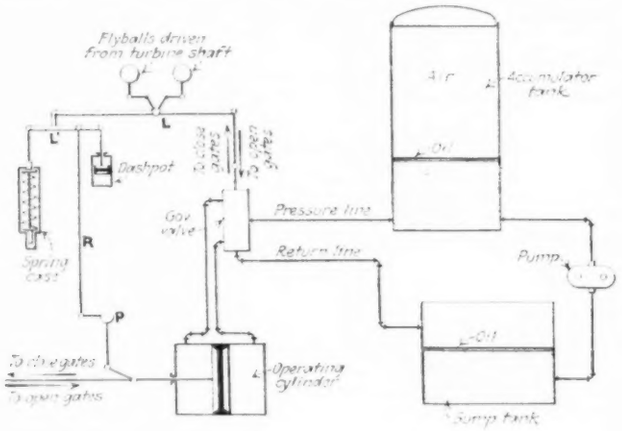


Fig. 5—Diagram of typical hydraulic-turbine governing system

by having certain power stations operating as regulating units, in case the change in load would affect the system speed beyond the limit of the sensitiveness of the various governors in these particular stations. Thus, the small unit would be called upon to operate only at constant load without the necessity of aiding in the speed regulation of the system. It is only on very large systems, however, that this condition is found, and even then it is subject to certain other considerations that may make it desirable to have a governor installed with the turbine.

Sudden Load Changes on the Turbines

With larger changes in load occurring suddenly, which affect the speed more than one-half to one-fourth of one per cent from normal, the governor must act to adjust the difference between the original load and the new demand. To understand the action of the governor better under these conditions, a detailed description of the successive operation of the various parts and the attendant hydraulic phenomena is necessary.

For example, consider a plant under a head of 200 to 300 ft., having a penstock at least 500 to 700 ft. long, without relief valves or surge tanks. With an allowable pressure rise not exceeding 50 per cent of the normal head, the governor time would necessarily be fixed. Assume that the unit is operating at its rated capacity, supplying an isolated system without assistance from other generating units, and take, for example, the action of the governor following the complete loss of load equal to the rated capacity of the unit.

As previously described, the first result of a loss in load would be an excess of output over the required demand, causing an increase in the speed of the unit. As soon as this increase in speed exceeds the degree of sensitiveness of the governor, the turbine gates move toward the closed position, and in this particular case would probably close completely. The movement of the gates with respect to time would follow a curve about as shown in Fig. 1, where A represents the gate position before the load change and t the dead time of the governor. The fully closed position of the gates is represented by E, while D is the gate opening required to operate the unit at normal speed without load. The curvature at B and D is due to the inertia of the operating mechanism and the cushioning of the cylinders near the closed position, respectively.

The movement of the gates decreases the flow through the unit as shown by the turbine-discharge curve in Fig. 2, the letters referring to the same conditions as noted in Fig. 1, which apply throughout the four diagrams. The reduction in discharge causes a change in velocity in the penstock, resulting in a reduction in the momentum of the water column between the turbine and the intake and also, to some extent, in the turbine itself and in the draft tube. This reduction in momentum manifests itself as a rise in pressure at the turbine, shown by the penstock-pressure curve, Fig. 2, with the result that the movement of the turbine gates may readily cause a momentary increase rather than a decrease in the power input to the turbine, thus producing at first the opposite effect from that desired. As the gates continue toward their closed position, the reduction in discharge is sufficient to overcome the resultant increase in pressure, and when the speed of no-load position is reached at D, the power output approaches zero. The total time for the full-gate movement is OE, as shown in Fig. 1. The variation in pressure and discharge as shown in Fig. 2, caused by this gate move-

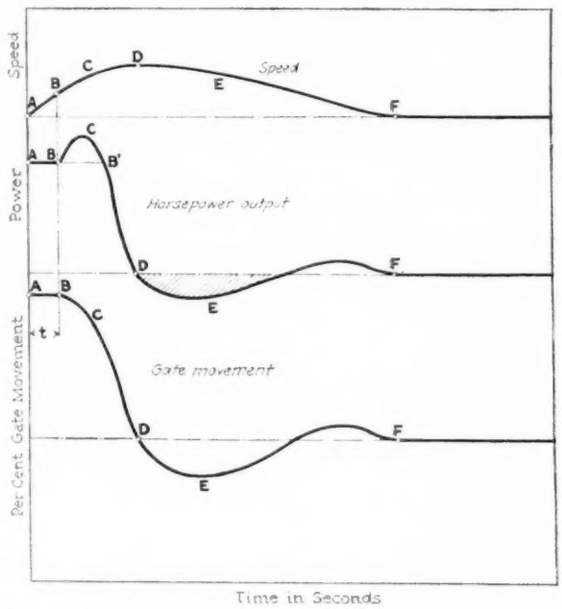


Fig. 6—Shows graphically the events that occur when the load is reduced from 100 to 50 per cent on a turbine

ment will, when combined with the efficiency of the turbine at various points from full load to zero, result in a variation in power output of the turbine, somewhat as shown in Fig. 3. During the dead time t, the power remains normal as shown from A to B, then, with the movement of the gates the discharge is reduced which causes an increase in pressure BC, Fig. 2, giving a greater output BCB', Fig. 3, than the original load carried. From B' the output decreases until D is reached, when the output equals zero corresponding to

the speed of no-load condition. During this time, which is equal to *OD*, the excess energy *ABCB'D* has been transferred to the rotating element and has caused an increase in speed as shown for the corresponding time in Fig. 4.

The condition is now such that the gates are in the proper position to operate at normal speed without load, but owing to the excess energy transferred to the rotating element, the speed is far in excess of normal. To correct this, the gates continue to close from *D* to *E*, Fig. 1, and cause a corresponding reduction below the power required to operate the unit without load. This is shown as *DE* in Figs. 3 and 4, and continues until the speed returns to normal at *F*.

The foregoing cycle of events in this particular instance would probably require a total of 3½ sec. from *O* to *E* including the dead time *t*. From *E* to *F* the operations would require from four to fifteen seconds or even more, depending upon the rise in speed, the flywheel effect of the rotating parts and the leakage through the turbine gates when closed.

For reduction in load of less than the rated capacity of the unit the same cycle of events is followed except that the governor is able to over-travel slightly the final position, which results in a deficiency in output over the demand similar to that shown as *DEF* in Fig. 3, tending to return the speed to normal following the change in load. The variations in speed resulting from a decrease in demand from full load to half rated capacity, together with the corresponding power change and gate movement, is shown in Fig. 6.

Primary and Secondary Compensation

The definition given in the foregoing in regard to correct primary and secondary compensation may better be illustrated by reference to the diagram shown in Fig. 6, which illustrates the action of the governor and the various phenomena occurring during a fractional-load change. The first action of the governor starts at *B* in the same manner as with the complete loss in load and closes the gates to some point *E* and returns them to *F* as soon as the speed becomes normal. When the increase in speed occurs from *B* to *C*, the flyballs have raised the pilot valve some distance above the normal position. As soon as the turbine gates have started to move, the compensating devices come into play actuated by the restoring connection directly connected to the turbine-gate mechanism. The tendency of the first compensation, as previously explained, is to restore the pilot valve to its neutral position, thus tending to stop the movement of the turbine gates. When the gates have moved a sufficient distance for the first compensation to close the pilot valve, the movement is stopped at some point corresponding to *E* in the digram; thus the gates have, to some extent, over-traveled their final position, which would be along a line *DF*. However, the situation now is that the flyballs are considerably above their normal position owing to the speed being high, hence the gates must remain in the over-traveled position until the speed has returned more nearly to normal. While this process was going on, the secondary compensation was coming into action, tending to counteract the effect of the first compensation by allowing some additional opening of the gates. This assists in holding the gates below the position corresponding to the new-load demand. However, as the speed is now returning to normal on account of the deficiency in power output over the demand, the compensation is adjusted to return the gates slowly from *E* to *F*, where they take up the position corresponding to the new-load demand. However, as the speed is now returning to normal on account of the deficiency in power output over the demand, the compensation is adjusted to return the gates slowly from *E* to *F*, where they take up the position corresponding to the new-load demand.

Controlling Features

The change in speed of the turbine is therefore controlled by four functions: First, the dead time of the governor, *A* to *B*, Fig. 1; second, the traversing time of the governor *B* to *E*; third, the hydraulic phenomena caused by the closure of the gates, shown in Figs. 2 and 3; and fourth, the flywheel effect of the rotating parts. Of these, the first is usually a fairly fixed amount, probably not in excess of one-half second; the second and third, however, are adjusted to give the best regulation possible within practical limits. The penstock length and diameter, coupled with the allowable pressure rise above normal, usually fixes the minimum governor traversing time that may safely be employed, and with these two elements fixed, the allowable variation in speed for full-load change becomes a question solely of the flywheel effect of the unit.

The proportional time required for fractional gate movements can be established as a definite percentage of the full stroke and, with the flywheel effect established, determines the various amounts of speed change that will take place due to sudden fluctuations in the load demand.

It is readily possible to calculate exactly the result of a given load change, as illustrated in Figs. 1 to 4, by applying the theory of rise or fall in pressure and the well-established principles covering the conversion of this excess or deficiency in power into a change in energy of the rotating parts.

A New Cast Iron for Engine Cylinders

A metal attracting much attention abroad is Perlit, a cast iron invented and worked in the foundries of Heinrich Lanz, of Mannheim. According to *The Engineer*, London, by subjecting the metal to careful metallurgical control as to its composition and by preheating the mold and core so that the rate of cooling of the casting is correlated with the thickness and the mass of the casting, it has been found possible to produce a pearlitic structure throughout all sections. The casting is tough and malleable and shows a marked difference in fracture as compared with that of ordinary cast iron. The gray iron so produced is remarkably low in its silver content and is largely immune from growth when exposed to high temperatures, which gives Perlit iron a particular importance for oil-engine work. A considerable amount of development work in connection with the production of standard castings of Perlit iron has been carried out in England and Germany.

The consistent qualities of Perlit iron are such as to render it to all intents and purposes a new metal. It is claimed that, for the first time in iron founding, a cast metal can be produced possessing properties that permit of the strength and weight of any casting being predetermined with an accuracy that up to now has been associated with mild-steel constructional work alone and lacking objectionable feature of growth encountered in cast irons under high-temperature conditions.

Starting Synchronous Condensers Controlled with Voltage Regulators

By J. H. Ashbaugh*

IT IS quite common practice to use a synchronous motor without mechanical load (commonly called a synchronous condenser) to correct for power factor and to maintain voltage on power lines. A synchronous condenser connected to the line has the same characteristics as an alternating-current generator except that it does not have any prime mover to drive it and it cannot, therefore, supply any kilowatt load. The power to drive the machine is obtained from the line, but as it has no load, it requires only sufficient power to overcome the friction, windage and core losses, which are very small.

The action of a condenser with regard to the field excitation is precisely the same as that of a generator. If the field current is increased above normal, the increased voltage in the armature will cause it to send a current on the line which is lagging with respect to the internal generated voltage, but leading with respect to the line voltage. The generated voltage is in opposition to the line voltage. Thus, one may say that a condenser over-excited draws a leading current from the line and will correct for that part of the line current that is lagging. The line voltage will, therefore, rise.

When the condenser is under-excited, the opposite holds true; that is, the condenser furnishes a lagging current and holds the line voltage down, inasmuch as the leading current on the line causes the voltage to rise. From the foregoing it is readily seen that by varying the excitation the voltage is varied just the same as with a generator. A voltage regulator that is designed to operate on an alternating-current generator will likewise operate on a synchronous condenser to hold any voltage for which it is set.

Use of Voltage Regulators

Voltage regulators have been used on synchronous condensers since their inception. The usual method of operation is to start the condenser first with a weakened or short-circuited field, then adjust the field current to a point where the change from the starting to the running tap is the least disturbing, after which the running switch is closed. With the condenser then on the line, the voltage regulator is placed in service in the usual manner. However, there is a simpler method of placing the regulator in service, which is probably not in general use. With this new method the condenser can be brought up to speed and placed on the line with the regulator in control, thereby reducing any disturbance incident thereto to a minimum.

When the condenser is to be started, the regulator switches are closed first, thereby connecting the regulator to the exciter; that is, all the switches to the regulator are closed just the same as if the machine were running and all the rheostats set on the marked or running position. The main condenser field rheostat alone is not on the running position, but turned to the "all in" position. With this rheostat in this position the field current will be very low or zero if the machine has a direct-connected exciter, so that the condenser starting switch can be closed. When the machine has reached its maximum speed on the starting switch, the condenser field rheostat is turned toward the "out" position until the field current is at the correct value for smooth transfer to the running switch. The running switch is then closed, after which this rheostat is slowly turned to the "all out" or marked position as the case may be. When the rheostat is turned in this direction, the field current will increase and the voltage will build up so that the regulator will start to vibrate in its usual manner.

Many condensers are required to operate under-excited during times of light load on the system and over-excited during heavy loads. Thus, the excitation requirements may have to vary over a wider range of voltage than that in which the exciter can be varied by the regulator. In other words, the voltage across the slip rings of the condenser may have to be lower than the exciter voltage can be lowered by the regulator. In cases of this kind the vibrating regulator is supplemented by automatic control which cuts in the condenser rheostat, it being motor-operated, when the exciter reaches a predetermined low point and cuts it out when reaching a predetermined high point. The rheostat absorbs some of the resistance drop, so the slip-ring voltage is lower than the exciter voltage. A regulator with these characteristics is known as an extended range regulator. When this type of regulator is used and it is desired to start the condenser, the control to the rheostat should be thrown from the automatic to the hand position, and the procedure outlined in the preceding paragraph should be followed until the regulator has started to vibrate. The control switch can be thrown to the automatic position when the regulator is vibrating, after which it will automatically turn this rheostat to the correct position.

When it is desired to shut the condenser down, regardless of the type of regulator used, it is only necessary to trip the running switch and then turn the condenser field rheostat to the "all out" position. There should be no delay in this, since the regulator will increase the exciter voltage to the maximum as soon as the machine is tripped from the bus, thereby increasing the field current. However, this is really not detrimental as it is only for a very short time. The rheostat must be turned to "all in" before starting, so it is easy to form the habit of doing this at the same time the machine is tripped from the bus. This method of operation is logical and has the advantage of being the simplest possible, and in practice it has been found far superior to any other method of operating.

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Error in Instrument Article

Correction should be made of a serious error that appeared on page 833 of the Dec. 1 issue in the article, "Instruments in the Private Power Plant." Fig. 4, showing a row of instruments, was given the caption, "Group of seven electrically operated flow meters measure distribution of steam and air from the co-operative power plant at Reading, Pa." A photograph answering this description was on hand, but that actually reproduced was a row of seven Bailey Flush-Front Fluid Meters installed in the new Equitable Building, New York City.

Standardization of Pipe Joints and Fittings

THE American Engineering Standards Committee has been working for a long time on the standardization of dimensions for pipe joints and fittings, with special attention to those items which affect the strength and tightness of joints. They have thus far developed standards up to and including material suitable for use with 900 pounds per square inch steam pressure.

Inasmuch as the use of higher pressure is increasing rapidly, it is highly desirable that standards be established for pressures up to thirteen hundred or fourteen hundred pounds per square inch, and a number of manufacturers and others have already established their own standards for such pressures. This results in considerable confusion and is highly deplorable.

One proposal for a thirteen hundred pound standard is to use the dimensions already standardized for nine hundred pounds, but to make the flanges, fittings and bolts of alloy steel, heat-treated to develop maximum strength. This suggestion implies greater confidence in the properties of alloy steel and in the permanence of those properties than is justified in the present state of our knowledge of metals. It is well known that all steels begin to lose strength at seven hundred or eight hundred degrees Fahrenheit, but in addition to this it appears that heat-treated alloy steels, when held at such temperatures, are partly or wholly annealed, with more or less complete loss of their special properties.

It is obviously desirable to keep the bolt circle as small as possible through the use of smaller flanges and smaller bolts and nuts, but it is unwise to attain the end by the use of material whose dependability is open to question, especially at the elevated temperatures that characterize present steam practice.

The results of a failure in high-pressure steam piping would be so disastrous that any use of materials that are in the least bit doubtful is open to serious objection.

It is to be hoped that the American Engineering Standards Committee will make haste to consider high-pressure service and establish suitable dimensional standard for use with ordinary mild steel.

The Case of the Large Diesel

THE arrival of the Swedish motorship "Gripsholm" at New York early in the month was awaited by many whose interests lie in other fields than the merchant marine. The maiden trip of this vessel has proved that large Diesels can be built and operated as successfully as a small unit. Much has been made of a sixteen thousand horsepower Diesel in process of construction in Germany, but the history of the two large units experimented with for several years during the war was such that no great optimism was justified as to the success of the newer unit for the City of Hamburg.

While the "Gripsholm's" main engines do not approach the Hamburg unit in capacity, each of the double-acting engines develops over eight thousand horsepower.

The design embraces several novel features, the outstanding one being the combustion chamber used with the lower cylinder end. This combustion space is in the form of a partly cooled bulb or chamber at one side of the cylinder space. The air, exhaust and fuel valves are placed in this chamber without any of the troubles that might naturally be anticipated. Compression in the lower end of the cylinder is low, and combustion does not occur here until the continued operation of the engine under the influence of combustion in the upper end of the cylinder increases the engine's working temperature. In effect the engine is a combination of a Diesel and a low-compression hot-bulb engine.

Without an examination of indicator diagrams it is impossible to state the effect this combination has on the relative proportions of the power developed in the upper and lower ends of the cylinder. Making proper deduction for the rod, it would seem that at least two-thirds of the power is developed in the upper cylinder end. The effect upon the power transmitted to the propeller is unchanged, but this unbalancing must tend to set up vibrations in the crankshaft.

The builders, Burmeister & Wain, are to be commended for the pioneering spirit displayed in the development of these engines and for their boldness in adopting a piston speed of over twelve hundred feet per minute for six-cylinder units with a bore of thirty-three inches and a five-foot stroke.

The Constitution of Coal

ENGINEERS become accustomed to think of bituminous coal in terms of the proximate analysis. Each pound therefore consists of a certain percentage of moisture, ash, volatile matter and fixed carbon. Our ideas that a certain portion of the coal consists of carbon in the so-called fixed state is largely based on the fact that anthracite contains little else than carbon and some ash. The carbon in anthracite is definitely in a fixed state and therefore one can easily conceive of at least a portion of the carbon in bituminous coal being in a similar fixed state.

Recent studies are throwing some doubt on the presence of any large amount of bituminous coal occurring in a fixed state. It is now quite generally recognized that coal is principally composed of decomposed vegetable matter. It therefore originally consisted of derivatives of cellulose or humus and of resins together with certain nitrogeneous compounds. Vegetable fibers contain no fixed carbon as such, and hence any that may be in the coal, is produced by certain decomposition changes that it has undergone. In fact, our laboratory method of determining fixed carbon consists of accelerating decomposition changes by heat and of weighing the residue as fixed carbon and ash.

When coal is heated, it passes through a certain stage when gases and tars are given off and the cell struc-

ture is destroyed to be replaced by a new grain structure called coke. If the coking process of a coal is observed closely, it will be noticed that the whole mass fuses and bubbles like a concentrated solution. This suggests that the fixed carbon is a decomposition product rather than an original constituent of the raw coal.

Quite recently, Bergius in Germany has developed a process whereby he hydrogenates raw bituminous coal into liquid fuel. He puts coal into a retort, pumps hydrogen in at about two thousand pounds per square inch pressure, heats to about one thousand degrees Fahrenheit, and the resultant mass consists of oils, tars, etc., up to seventy per cent of the original coal substance.

This naturally suggests the question "What really is coal?" Much research has been done and more must be done before this can be answered. When its true composition is known one can use it to better advantage either for combustion purposes or to produce liquid products. Until then we must muddle along with present haphazard ways of using the most valuable natural resource.

Governing of Steam and Hydraulic Turbines

CONDITIONS under which hydraulic turbines operate are vastly different from those common to steam units. A steam turbine operating on steam conditions of three hundred pounds and seven hundred degrees total temperature will have a water rate of about ten pounds per kilowatt-hour. A hydraulic turbine using this pressure would be operating under a static head of seven hundred feet and would require about four thousand pounds of water per kilowatt-hour. In one case the fluid is a highly elastic gas; in the other it is practically a non-compressible liquid. In addition the hydraulic turbine may be connected to a penstock one thousand feet or more in length, containing millions of pounds of water moving at ten or twelve feet per second, which must be brought to rest in a few seconds if full load is dropped off the unit.

The largest single-cylinder steam turbine and the largest hydraulic turbine are approximately of the same kilowatt rating. The steam turbine under full load will require about five hundred thousand pounds of water per hour, in the form of steam, while the hydraulic unit requires over seven hundred million pounds of water per hour, or fourteen hundred times that for the steam unit. To the hydraulic turbine is connected a penstock over six hundred feet long, which contains over thirteen million pounds of water moving at about eleven feet per second at full load on the machine. In the hydro-electric unit the flywheel effect (WR^2) is about sixty times as great as that in the steam turbine. Nevertheless, on account of the much higher speed (about seventeen times) of the steam unit, the kinetic energy stored in its rotating element is about four or five times as great as for the hydraulic unit. All these and other conditions have an effect upon the problem of controlling the speed, or governing the two types of machines. Even the governing equipment of the two machines is vastly different. Where the moving parts of the governor for the steam turbine are comparatively light and move in a highly elastic gas, those on the hydraulic machine may weigh many tons in a viscous, practically non-compressible fluid.

The steam flow to the steam turbine can be cut off practically instantaneously without any serious effects. On a hydraulic unit, if such a practice were attempted with the water, the increase in pressure due to water hammer would wreck the penstock, as has been evidenced in a number of cases. As indicated in the article, "Hydraulic-Turbine Governing," in this issue, closing the gates on the turbine faster than a given rate may momentarily cause more energy to be delivered to the wheel at part gate than at full gate, owing to the increase in penstock pressure. These features put a limit on the time that it is possible to bring a hydraulic turbine speed back to normal after a load rejection. Similar conditions exist during the application of load, but these have to do with reductions of pressures in the penstock, which may be as disastrous as increases in pressures if not kept within certain limits. Those who are familiar with steam-turbine governors and read this article on hydraulic turbine governors, should not blame the design of the governor for requiring five or six times as long to bring the unit under control after a change in load, as is required for the governor on the steam turbine.

What Is a Liberal Education?

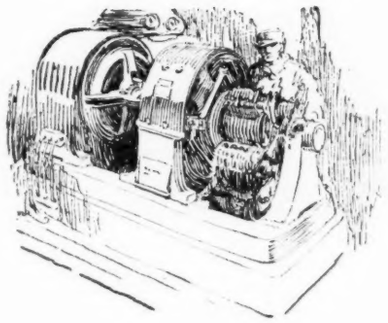
GREEK and Latin were once viewed as prime essentials of a liberal education. To rub it in a bit, these were termed "the humanities," the implication being that no other studies had equal capacity to extend the range of one's sympathy and imagination. According to this artificial code the scholar who knew his dead languages, ancient history and two or three other fixtures of the traditional curriculum, was thereby liberally educated and humanized. It mattered not if he were a veritable "babe in the woods," not only in business, engineering and the mechanic arts, but even in such scholarly pursuits as pure science and economics.

This unliberal standard of a liberal education has been discarded by the wise men of this generation. They understand that a specialist in any line, whether it be the so-called "humanities," engineering, law, plumbing, mathematics or salesmanship, may be extremely narrow. Some engineers are narrow, some are liberally educated, and the same applies in every other field. The fundamental error of the old definitions of culture and liberal education lay in the attempt to tag certain subjects as liberal and others as practical. Practical experience in plumbing is not liberalizing to a plumber, but might do much to broaden a divinity student or professor of Greek. As Dean Kimball, of Cornell, recently remarked, the study of music is vocational for the musician, but liberal for an engineer. Any study that broadens one's sympathies and increases one's points of contact with the world is part of a liberal education.

Whether a man be a lawyer, professor, physician, business man, scientist or engineer, he falls short of his opportunities if his interests do not extend beyond his own field. Every man should broaden his contacts with life and his fellow men. The engineer, in particular, should keep up interest in other fields.

The very precision and directness of an engineer's professional training makes him capable of the finest development as a liberally educated man. There are such engineers — Herbert Hoover is an outstanding example—whose life cannot be confined within the limits of any single field of human endeavor. They are the men who get the most out of life.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for November will be announced next month.

Stage Heating in the Industrial Plant

Most industrial-plant engineers do not think it advisable to incorporate in the design of an industrial plant, the refinements found in the large central stations, believing that the savings do not warrant the extra investment. In many of these plants refinements would result in a reduction of operating costs without increasing the investment charges to any great extent.

For instance, a recent idea developed by the newer central stations could be applied to almost any plant at no initial outlay for equipment. That idea is the heating of feed water to a high temperature by means of bled steam which has been partly expanded in an engine and has done considerable work, at only a slight decrease in heat content. Of course the idea cannot be carried as far in the industrial plant, since we know that these plants are not equipped with bleeder turbines tapped for steam extraction at more than one pressure. This idea was applied by the writer in an old plant where the equipment was far from modern and the management would not sanction any expenditure for improvements. Power was furnished by two 250-hp. Brown engines for the beater room, rag room and converting plant, while the paper machines were driven by two Watertown compound engines of 75 hp. each. The load on each machine engine was 40 hp., and in case of emergency one engine could drive both machines, as the driving shafts of the two machines were connected by means of a clutch.

The exhaust of these engines was used in the driers, and considerable live steam was used to bleach rags in the bleach boilers at 60 lb. pressure. The possibility of using exhaust for this operation was considered, but on account of the pressure required, no satisfactory method could be found with the equipment we had. The main engine ran condensing, as no demand for so large a quantity of exhaust existed. The feed water, consisting of condensate from the paper machines and make-up from the condenser, was heated to 200 deg. in a closed heater by the exhaust of the condenser pump and boiler-feed pump. The condensate from the machines at 240 deg. and makeup at 130 deg. flowed to a receiving tank, which was just an old bleach boiler equipped with a float valve to control the water level in the tank.

The possibility of bleeding the receiver of one of the compound engines in the machine room occurred to me, and I started to work the plan out. These engines were not fully loaded and the receiver pressure was 35 lb. and the engines exhausted at 10 lb. back pressure with an initial pressure of 140 lb. But the exhaust steam was not enough to supply the driers, as I soon learned, and any steam bled from the receiver would reduce the amount of steam exhausted from the low-pressure cylinder, an undesirable feature in this case, as the amount of live steam would be increased by it.

Studying the problem further, I reasoned that as one engine was large enough to run both machines, the engines were now operating at only half load, which meant an increased water rate. As an experiment the following Sunday, the No. 2 engine was connected to No. 1 machine by throwing in the clutch and the other engine cut out. My idea was to connect No. 1 engine to beaters by means of a belt from the flywheel to a pulley on the beater-room shaft. When starting up on Monday morning, the No. 2 unit carried the load of both machines satisfactorily, and there was a marked decrease in steam consumption, for this engine now operated at full load. This was proved by the reducing valve opening up more on the live steam connection to the machines, as one engine could not maintain the desired back pressure on the driers, but of course the total steam flow to the driers was the same, the extra live steam being equal to the difference in steam consumption between one engine at full load and two engines at half load.

The total steam used by the driers on a previous test was 4 lb. per lb. of paper run over the machines. As these machines ran at maximum speed all the time with a combined capacity of 1,000 lb. per hour, the total steam flow was 4,000 lb. per hour. The water rate was estimated from indicator diagrams to be 40 lb. per hp. at half load, making the total steam consumption of the engines 3,200 lb. per hour, leaving the balance of 800 lb. to be made up by admitting live steam, but the only accurate figure was the total steam flow, the percentages being more or less assumed. With the new plan a heavy load could be put on the small engine after connecting it to the beaters, so that it could exhaust exactly as much steam as could be used both for drying and for heating the feed water.

The method of bleeding the receiver was to be done as follows: Our heater was of the closed type and to heat the feed to a high temperature I intended to bleed steam into it at the maximum pressure in the receiver which was strong enough to stand boiler pressure. To condense the exhaust of the pumps, coils were placed in the receiving tank and raised the temperature to nearly 200 deg. before the water entered the heater. The tank had a manhole in the top and ends, and the

top was left open with a hood placed over it to conduct the vapor to a vent pipe. The only thing purchased was a second-hand belt to transmit power from the machine room to the beater room.

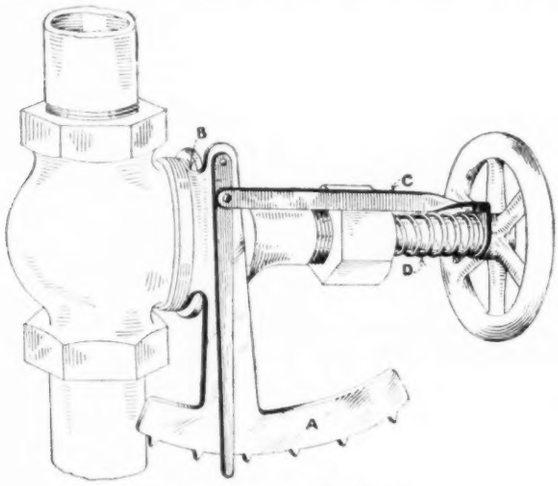
In operation the engine exhausted from the low-pressure cylinder to the driers as formerly and steam was bled from the receiver at 45 lb. to the feed heater. Just enough load was carried on the engine to maintain 10 lb. back pressure on the driers without using any live steam except when beaters were empty once a day. Indicator diagrams showed the power output of this engine to be 74 hp., and the final feed temperature was 281 deg. Bleeding steam for feed heating increased the power output by requiring a greater steam flow through the high-pressure cylinder without giving an excess of exhaust at the low-pressure end. The engine driving the paper machine developed 80 hp. making the power of the two engines supplying process steam demand total 154 hp. instead of 80 as formerly. The load on the condensing units was reduced by 74 hp. and, as this engine used at least 2¼ lb. of coal per hp. and the small engine only about ¾ lb., the heat depletion of steam in this engine being only 4 per cent, the coal saved is 148 lb. an hour. The running schedule being 144 hours a week, 10 to 15 tons is saved weekly by an initial expenditure of $50. Had the main unit been a bleeder turbine, steam for bleaching could have been bled at 60 lb. and further economies realized from this principle.

J. A. MADSEN.

Chicopee, Mass.

Valve-Opening Indicator

Numerous times it is desired to know the amount of opening a valve has, when it is not practical or convenient to close it in order to find this condition. A home-made device that we have made and attached to several valves in our plant is shown in the drawing, and its parts and operations are as follows:



Valve Opening Indicator

The main frame *A* is made of sheet metal, usually brass, although steel will answer. This is $\frac{1}{16}$ in. thick and in other dimensions in proportion to the size of the valve. This frame is attached by separating the valve-stem body from the main body of the valve and placing the threaded portion of the latter through the hole at *B*.

The pointer is pivoted on the frame *A* and is attached to the link *C*. The end of the link *C* encircles the valve stem, and a spring *D* holds against the handwheel and thus prevents lost motion of the pointer.

Washers may be placed inside or outside of the end of the link and over the valve stem to adjust the pointer at a zero position when the valve is closed.

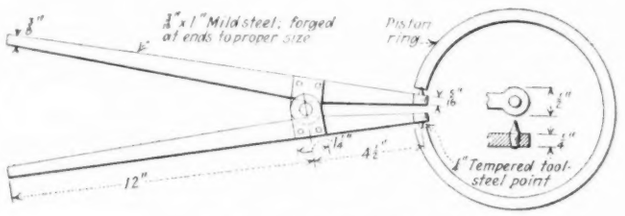
Projections on the frame *A*, with which the projecting end of the pointer corresponds, will show the operator, by feeling, just the amount of opening the valve has. The engineer or fireman can observe the valve position from a distance, so that extra steps may be saved in the routine of the work.

GEORGE MCVICKER.

North Bend, Neb.

Device for Removing Piston Rings

In removing rings from the piston of gas and oil engines we use old phonograph springs 6 to 8 in. long with a short section at one end bent at right angles to prevent the strip from slipping out of place. The



Piston ring expander

illustration shows a device we use in putting the rings back on the piston. This expander, when fitted with sharp tool-steel points, will take hold in the ends of a step-joint ring. For rings whose ends are cut on an angle we use a center punch and make a small punch mark on the ends. With this expander the rings are handled without unnecessary straining or risk of breaking them.

D. W. LEWIS.

Fessenden, N. D.

A Spider Wrench for Removing Valve Seats

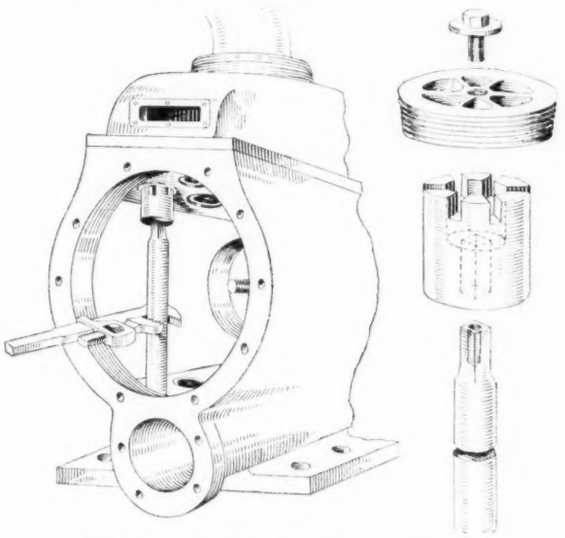
In our plant we have two old-style horizontal double-acting duplex steam pumps that supply the water pressure for seven hydraulic passenger elevators. I recently overhauled one of these pumps, and as the parts were quite heavy and the space around the pump somewhat limited, I decided to dismantle only such parts as were absolutely necessary, so that in case anything should happen to the other pump, I would be able to get this one in service again without much delay.

As can be seen from the accompanying sketch, which shows a part of the water cylinder and valve chambers, the removal of the valve seats for refacing presented a problem. To facilitate this part of the repair, I made the tools shown at the right in the illustration.

The spider wrench was made from a round piece of soft steel about the diameter of the valve disk and approximately one and one-quarter times as long. The grooves were laid off from a paper templet of the valve seat. Of course the job required no fine machine work, so most of the metal was removed in the drill press and the final finishing done with a hammer and cape chisel, dressing off the burrs with a file. The turning rod was of ordinary cold-rolled steel squared at one end to fit

the square hole in the wrench. The squared end was also drilled and tapped for a standard machine screw.

In making the repairs the pump plunger and liner were first removed and the spider wrench and rod placed in position from the under side of the discharge-valve seat. A small machine screw with a washer below the head was then screwed into the rod from the top of the valve seat, which held the wrench snugly in place. As the seats had been in place for a number of years, it required considerable effort to start them moving. However, the job was satisfactorily accomplished with the aid of a 4-ft. stilson wrench, after which a 12-in. wrench was sufficient to turn the seat



Tools used in removing valve seats

out. Although a little time was required to make the tools, it resulted in considerable saving of time and effort in completing the repairs. GEORGE W. WOOD.

Brooklyn, N. Y.

The Case of Fusion Welding

The fusion weld appears, to many who should be competent to pass judgment, to have been weighed and found wanting. Many reasons have been advanced for this and possibly another viewpoint may be of interest.

A fusion weld is generally understood to be the union of two pieces of metal by means of heating the pieces to their fusion temperature at the point where they are to be joined and bringing them together, the flowing metal from the two pieces uniting to form the fusion weld. When it is necessary to cut away a portion of either or both pieces or when it is desirable to form a fillet, metal from an outside source may be added.

The actual process of making a fusion weld is much more involved than it seems to be, requiring as it does technical knowledge, practice and skill.

We have been assured that a fusion weld, properly made, should be as strong as the original piece. In the case of a construction job it would appear, even to a layman, that a welded joint on sheet stock should be as strong as a riveted joint of the same construction and stock, provided the cross-sectional area of the fused joint is equal to the sum of the cross-sectional areas of the rivets used in the riveted joint. It is a fact, however, that fusion welds on pressure containers are viewed with suspicion by engineers.

I believe the objections may be summed up in part, at least, as follows: (1) Inadequate equipment; (2) ignorance on the part of the operator; (3) indifference on the part of the merchandiser, and (4) failure on the part of the user to realize the value of properly executed work.

The first two reasons are really one, as none but an ignorant operator would undertake so important a job as the construction or repair of a pressure container with inadequate equipment. The last two also go together, for the merchandiser will quickly lose his indifference when the user's demand for quality takes him to another market.

It is not so hard to understand why these objections apply to the product of the average repair shop. The proprietor buys a welding outfit because his competitor has one. They don't cost much anyway, and he turns the apparatus and the instruction book over to George. George may be a good mechanic but not a heavy reader. He looks at the pictures in the instruction book and decides that welding is a simple job. He probably heard the salesman tell the boss so when the outfit was purchased. He next assembles the outfit, rustles a couple of pieces of scrap and places them conveniently. Then he picks out a welding rod that looks as if it would do the job and either lights the torch or turns on the juice. With untold patience and lots of flux he eventually succeeds in getting the two pieces of scrap to hang together. After that he is a welder.

He does not know whether the two pieces of scrap are welded or merely soldered. They may not even be the same kind of metal, but that does not bother him for he does not know that it makes any real difference whether they are or not. Neither does he bother whether the welding rod is of the right composition for the job. As for deciding whether the work should have been preheated, beveled, cleaned or fluxed, these mean nothing in his young life. Anyway, from the time he succeeded in sticking the two pieces together he is "George the Welder." This is the type of man that does too many of our repair jobs and has done more to discredit fusion welding than any other factor.

The instructing and training of a real welder means time and expense, and someone has to pay for it. Such a workman can command pay above that of the average mechanic. It is not surprising, then, that the welding job turned out by many repairmen is unsatisfactory.

The case of the manufacturer is entirely different. He can and, as a rule, does know the metals he is working with. He can obtain equipment suited to the job he is producing. He can employ or train skilled operators, inspectors and supervisors. His finished product can be tested to permit reasonable assurance that it will perform satisfactorily under the conditions specified.

Possibly the reason we have had so many cases of unsatisfactory fusion-welded pressure containers is that engineers have not fully realized the advantage of this type of construction and have not demanded work of a quality consistent with its importance. I am confident that the manufacturer can and will produce it if it is profitable for him to do so.

Many innovations have been made and many time-honored practices discarded in the last ten years and I think that eventually the fusion-welded joint will be placed on a par with, and in many cases preferred to, the riveted joint in pressue-container construction.

Devon, Conn. L. A. PIERSON.

Comments from Readers

College Entrance Requirements for Engineering Students

I was much interested in the letters of David E. Davis and J. O. G. Gibbons in the Aug. 4 and Oct. 6 issues respectively, on the subject of college entrance requirements for engineering students.

The colleges of today are realizing more than ever before the responsibility that falls on them in the development of the youth of this country. Since the late war a great many technical schools have adopted some sort of mental tests modeled on those used in the army. The net result is that, although it is seldom that an applicant for admission as a freshman is rejected, he is so rated that he makes the best progress possible in classroom work.

All students of engineering cannot lead the class, nor can all graduates of engineering courses rise to positions of eminence. There will always be the chosen few, the good, the mediocre and the poor. It is a proved fact that a student's chances to reach the top in his chosen profession are in direct proportion to the scholastic standing he maintains during his college career. There are a few exceptions to this rule, of course.

I wish to call attention to the work of the various cooperative schools about the country. In these colleges the student is given a fair experience in the actual field of the industry that his studies cover, and he is also given the theoretical training. After all, the college can give the student only the fundamentals; the years of actual work that follow must make the engineer. The student is taught to rely on himself in the solution of his problems, to know where he can find needed information and, most important of all, to think for himself in a straight logical manner. Where we can combine theory and practice, we may expect the student to show the greatest progress, and yet, if he be truly a square plug, he will probably drop the courses voluntarily.

In a certain university in the Middle West there is a faculty ruling that no person can be employed as an assistant or an instructor in engineering unless he has had at least two years of actual practice in industry, in addition to the completion of his undergraduate work. This means that every member of the faculty knows the problems of the graduate upon leaving school. To further aid the students by an early insight into the fields of the profession, every freshman is required to take a course in "Engineering Problems," in which he gets an idea of the various phases of engineering. As a senior he hears weekly lectures by prominent engineers and business men. The graduate, therefore, cannot be entirely blind to his future problems.

In this same institution in a recent graduating class there were 136 members. Four years previous the class numbered more than 250. The percentage of failure, you will say, was high, but it was not so high as in previous years. Of this number, by far the most failures were among those students just out of high school and at an average age of about 18 years. These lads did not know their own minds, they had had no opportunity to converse with engineers, and in almost every case did not realize what the term "engineer" meant. They were sent to college to take something, and since this is a mechanical age, engineering seemed the logical choice.

It seems to me that one of the surest ways to reduce the number of failures is to keep the high-school graduate out of college by an age requirement, perhaps 20 years. By this time he will have had a chance to work a couple of years and in so doing will realize something of the problems he will have to face later. He will also have time to find himself and know what work he is best fitted for. The sobering effect of these few years' interval will show in a decrease in the number of failures among the freshmen. It is an interesting fact that among the men who work their way through college the percentage of failure is low. The same condition is true among the men who enter college at a more mature age, and it is not infrequently that we find men in college at the age of thirty, men who have given up remunerative positions and who are, quite often, married. The percentage of failure among such students is almost negligible.

It is during the interval between high school and college that we, as engineers, must step in and give the prospective college student the benefit of our experience by helping him to choose correctly his future work. Many young man will be glad to receive this advice and try to follow it, but we cannot expect the plan to work 100 per cent, for when the average college student is graduated he is usually in such circumstances that any remunerative position in the field is acceptable, whether it be along the lines of previous training or not.

In one of the foremost engineering schools of the country the freshmen are given a number of personnel rating blanks, upon which are listed such attributes as tact, appearance, dress, manner, initiative, ability to work with others, knowledge of fundamentals, health, etc. These blanks are sent to the students' acquaintances at home and on the campus, and to previous employers, with the request that these persons fill in under the different headings whether excellent, above average, average, below average or poor. Later, the blanks are returned to the office of the Dean of Engineering. The same procedure is carried out through the four years of the students college career and the rating tabulated. In addition to these ratings the student is also rated by the members of the faculty, in which the most important feature is to determine the type of work the individual is best fitted for; that is, sales engineering, drafting and design, research, teaching or executive.

At the close of his course he is called to the office for a conference and is shown his rating as others see him and is given any information he may want. This record is available to the man and to his future employers and aids materially in getting the man and the job together. The record follows the individual after graduation, so that it becomes a record over a long time. Employers of the state contribute toward the main-

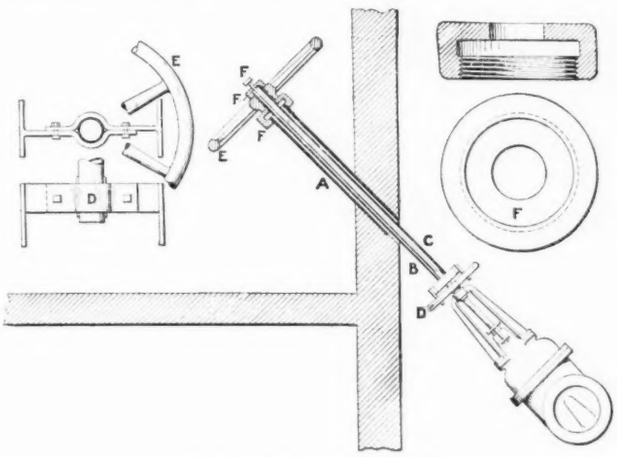
tenence of this system and they are finding themselves well repaid. The plan is receiving nation-wide acknowledgment and is certainly a step toward the solution of the problem of the college student and industry.

Detroit, Mich. GEORGE M. ARNOLD.

Valve Floor Stand

In *Power* of Sept. 8, a very neat floor stand was described by Lieut. C. B. L. Anderson. It was done up in true navy style, but requires special castings which are not available to every plant.

A short time ago a valve stand was needed quickly, and it was found that a practical arrangement could be built with ordinary pipe fittings. It will be noted from the illustration that this floor stand has a valve-



A low-cost valve stand

opening indicator made up of a small pipe *C* fastened to the valve stem and projecting up through the turning pipe *B*; this is of great value in many cases.

The cost of the material was small and labor costs were not much greater. If it is to stand on a concrete floor, it is not even necessary to use a base flange; the outside pipe can be cemented directly into the floor, the same as shown with the wall construction.

For material, three short pieces of pipe, *A*, *B* and *C*, a clamp *D*, two bolts, a standard handwheel *E* and three pipe caps *F* constitute all that is necessary. Such a stand is easy to assemble or dismantle.

Painesville, Ohio. MARSHALL S. GARE.

Does Extra Heating Surface Pay?

Referring to the letter of F. W. Dean in the Oct. 27 issue, in which he disagrees with some of the statements in the editorial in the Aug. 25 issue on "Does Heating Surface Pay?" it would appear that he has entirely misinterpreted some of the editor's remarks. The reduction in sheet sizes and tube lengths referred to, is in the number of standard sizes and not in the actual dimensions. The choice of the 72-in. by 18-ft. boiler was apparently not intended as an example of the largest size, but one of the best-known and most commonly used sizes which would be thoroughly familiar to every one. The editor expressed what many engineers have felt after operating return-tubular boilers for a while—a wonder how the boiler would work if it had a corresponding number of larger or smaller tubes, and a realization that most of the book statements as to relative advantages of large and small tubes were purely theoretical and opinions on the part of the author. Probably the largest collection of actual experimental evidence on the performance and effects of variation in proportions of fire-tube boilers has been obtained in locomotive boiler work, but it is difficult to adapt these definitely to return-tubular boilers.

I am rather surprised at Mr. Dean's statements regarding the crowding of tube surface into return-tubular boilers as evidenced by the use of 140 instead of 110 tubes. I have frequently visited a paper mill near Boston having return-tubular boilers designed along this line which have given no end of trouble from priming on account of insufficient steam space, so much so that superheaters were finally installed in an endeavor to secure reasonably dry steam. My own experience has been that return-tubular boilers have a higher draft resistance at comparable ratings than most water-tube boilers and that the flue-gas temperatures increase disproportionately rapidly when the boilers are forced to high ratings.

I think Mr. Dean would have better said that there is "no proof" rather than "no evidence" that the upper tubes carry a larger proportion of the gas flow than the lower, as in working around these boilers there are apparently indications that more and hotter gases pass through the upper tubes; that is, it is hotter in the upper part of the front end opposite the upper tubes than in front of the lower ones. When smoke comes through the tubes and it is possible to observe it through a cracked door or other opening, there seems to be more through the upper tubes than the lower.

A possible explanation of this may be as follows: There is a greater draft pressure available to cause this flow, for if, say, the distance between the top and bottom tubes is 4 ft., then in the rear connection we have a column of gases at about 2,000 deg., 4 ft. high, having a pressure of $4 \times \frac{32 + 461}{2{,}000 + 461} \times \frac{1}{12.39} =$ 0.0647 lb. per sq.ft., or about 0.01 in. of water. In the front connection with flue-gas temperature of, say, 500 deg. F. we would have a corresponding column of $4 \times \frac{32 + 462}{500 + 461} \times \frac{1}{12.39} =$ 0.166 lb. per sq.in., or over 0.03 in. of water; that is, about 0.02 in. of water greater available draft through the top tube than through the bottom one. Besides this, there are the lesser effects of the inertia of the gases sweeping up through the back connection, tending to carry them up until deflected into the top tubes by the rear connection arch and that the gases that pass through the lower tubes have been partly cooled by direct contact with the boiler shell, whereas those that pass up the back connection farther away to reach the upper tubes, have not.

The general ideas of circulation in fire-tube boilers agree fairly well, although they do not explain all the phenomena of corrosion by gases contained in feed water that have been observed from time to time. In view of the upset that recently published investigations have caused in our knowledge of scale formation in boilers, it is dangerous to be too positive on any points not well covered by experimental evidence, and it is likely that further research into boiler circulation will show unexpected phenomena such as have been found with model water-tube boilers and result in improvements such as anticipated by the editor.

New Haven, Conn. H. D FISHER.

Questions and Answers

Conducted by

Franklin Van Winkle

Determining the Specific Gravity of a Solid and the Derived Specific Gravity of a Liquid

A certain solid body when immersed in water weighs 5 lb., and when immersed in a certain liquid it weighs only 4 lb. If the weight in air is 7 lb., what is the specific gravity of the solid, and what is the weight per cubic foot of the second liquid? *M. D. S.*

When a body is immersed in a liquid, the loss of weight compared with the weight of the body in air is equal to the weight of water displaced. Hence if the loss of weight when immersed in water was $7 - 5 = 2$ lb., the specific gravity, or weight compared with an equal volume of water, would be $\frac{7}{2}$, or 3.5. If the same solid body when immersed in another liquid weighs only 4 lb. the weight of equal volume displaced would be $7 - 4 = 3$ lb., and since the weight of an equal volume of water displaced was 2 lb., the specific gravity of the second liquid would be $\frac{3}{2}$, or 1.5.

At ordinary temperatures the weight of water may be taken as 62.36 lb. per cu.ft., and if the specific gravity of a liquid is 1.5, it would weigh $62.36 \times 1.5 = 93.54$ lb. per cubic foot.

Saving by Installing New Oil Burner

I have one horizontal return-tubular boiler 72 in. by 16 ft., burning fuel oil. This is for steam heating, a vacuum system being used. The boiler pressure is 100 lb. Coal grates are in, covered with firebrick as close as possible without mortar. Under burner tip, an opening equal to the space required by six bricks, admits air to the furnace. The boiler is in operation 16 hours a day during winter, burning 300 to 400 bbl. of oil per month. Flue gas last week showed 9 per cent CO_2, CO none, and O 9 to 10 per cent. Have cut oil bill of former engineer $600 per year. Salesman for a different burner says he can cut oil bill 15 per cent. Do you think it would pay to install this burner? *A. B. T.*

The loss due to a low CO_2 is the sensible heat carried away by the flue gases in the excess air supplied. By increasing the CO_2 percentage, the excess air supply is decreased, followed by a decrease in the weight of flue gas and a decrease in the sensible heat carried away by the gases.

A ready formula, which is correct for all practical purposes is

$$L = K\frac{(T - t)}{CO_2}$$

where L = per cent flue loss, CO_2 = per cent of CO_2, $T - t$ = temperature difference between the flue gas and the air coming to the furnace, and K = constant (for oil this is 0.28).

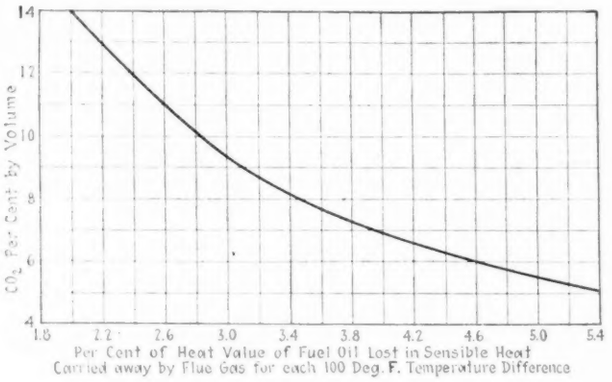
The flue-gas temperature is not given in the inquiry, but assuming this to be 500 deg. F. and the boiler air temperature as 80 deg., with 9 per cent CO_2 the per cent loss becomes

$$L = 0.28\frac{(500 - 80)}{9} = 13 + \text{per cent}$$

The maximum CO_2 obtainable with fuel oil under practical conditions is approximately 14 per cent. With this high CO_2 and lesser flue-gas weight the stack temperature would probably be 50 to 100 deg. F. lower in temperature than with 9 per cent CO_2. On these assumptions we have the loss

$$L = \frac{0.28(400 - 80)}{14} = 6.4 \text{ per cent.}$$

This decrease in loss is then $13 - 6.4 = 6.6$ per cent. If the boiler efficiency were 70 per cent with 9 per cent CO_2, it would then be 76.6 per cent with 14 per cent CO_2. The fuel saving would be $6.6 \div 76.6 = 8.6+$ per cent.



Loss Due to Low CO_2 per Cent

Obviously, then, a saving of 15 per cent is impossible under the assumed flue-gas temperature.

The chart shown in the illustration, based on a chart by Prof. G. F. Gebhardt, may be used in place of the formula given, although the answers may show slight discrepancies. For example, with 9 per cent CO_2 the per cent loss per 100 deg. of gas temperature is 3.1 per cent, for $(500 - 80) = 420$ deg. F. difference, the loss is $\frac{420}{100} \times 3.1 = 13.02$ per cent. With 14 per cent CO_2 and a 400-deg. flue-gas temperature the loss is $2 \times \frac{(400 - 80)}{100} = 6.4$ per cent. These check closely with the results obtained by using the formula.

By altering the brickwork so that the air can come in around the burner rather than only at the bottom, the CO_2 should be raised considerably above the 9 per cent existing at present. The 9 per cent oxygen indicates that the excess air per cent is about 100.

New England Engineers Discuss Fuel and Power Problems

Coal and Oil Fuel, and the Purchase or Generation of Power in Textile Plants, Paper Mills and Other Industries, Were the Subject of Several Papers. Attention Was Directed to the Diesel Engine, and to the Use of High Pressure Steam, with the Use of Exhaust or Extracted Steam for Heating

THE Affiliated Technical Societies of Boston joined in a two-day meeting on Thursday and Friday, Dec. 10 and 11, to discuss questions relating to fuel and power. The sessions were held in Huntington Hall, of the Massachusetts Institute of Technology, and the meeting concluded with a dinner in the evening at the Boston Chamber of Commerce.

The sessions were well attended, rarely less than 200 being present and at times double that number. Some 350 partook of the dinner.

The first session was called to order by F. M. Gibson, chairman of the Affiliated Societies, who introduced, as presiding officer, Dr. Ira N. Hollis, past-president of the A.S.M.E., retiring president of Worcester Polytechnic Institute and the first president of the Affiliated Societies.

Doctor Hollis said that the Affiliated Societies were doing a public service in emphasizing the importance of economical power, upon which New England, 75 per cent of whose activities are industrial, is so dependent. He pleaded for a renewal of the spirit of economy and welcomed this meeting as an urge in that direction.

Coal the Basic Fuel

The first paper, "Coal, the Basic Fuel," presented by F. H. Daniels, vice-president and general manager of the Sanford Riley Stoker Co., was illustrated by motion pictures depicting the formation, mining, preparation, coking and burning of coal.

Natural gas, he said, is practically exhausted, and its use in power production is negligible. Fuel-oil consumption has increased rapidly in recent years, and about 42 per cent of the original supply has already been used. The consumption for 1924 was one-twelfth of the known remaining supply.

It is evident that very shortly the United States will be increasingly dependent on imported oil, or upon low-temperature coal-distillation processes to yield fuel and lubricating oils. The use of oil as boiler fuel must be abandoned before long.

Coal presents a very different picture. Of anthracite, only about 15 per cent has been used, and of bituminous coal, less than 1 per cent. In addition there are immense deposits of peat and lignite. In heat units the remaining stores of coal amount to 1,370 times the oil reserves.

The United States burns each year about 640 million tons of coal, divided among various uses as follows: Industrial plants, 33.5 per cent; railroads, 25.0; domestic, 16.5; coke production, 13.0; electric utilities, 6.5; gas utilities, 1.0; bunker and export, 4.5.

Fuel supplies, once used, can never be replaced. Natural gas is gone; oil is about half used up; the development of all available water powers will require years of growth. For generations to come, coal must be the basic fuel—let it not be wasted. Conservation pays today, and is good policy for the future.

Oil Burning

E. H. Peabody, president of the Peabody Engineering Corp., followed with a talk on oil. While the use of oil for fuel should be discouraged, the business interest of the refiner leads him to sell oil at low prices for fuel when he cannot sell it for gasoline; and so long as there is oil in the ground, somebody is going to get it.

He showed illustrations of different oil burners, concluding with a description of his combined burner for oil and powdered coal now on trial at the Sherman Creek plant in New York City.

"Diesel Engines for New England Power Plants" was the title of a paper presented by J. F. Hecking, of the Worthington Pump & Machinery Corp.

The Thursday afternoon session was presided over by Dr. Samuel W. Stratton, president of the Massachusetts Institute of Technology. The first paper was, "Possibilities of Obtaining Power from Public Service Corporations," presented by L. R. Nash, of Stone & Webster, Inc., who said that approximately one-half the total power requirements of the industries of Massachusetts is furnished by the industries themselves and one-half is utility power, the proportion of the latter being appreciably greater than for the United States as a whole.

An efficient coal-burning station of large capacity (150,000 kw. or more) costs about $100 per kilowatt. The unit cost does not decrease materially for larger plants, but an increase is distinctly noticeable in smaller plants.

Public utilities have, therefore, a distinct advantage in the lower unit cost and carrying charges of their power stations, offset only in part by the cost of the transmission and distribution. Other advantages are the diminishing percentages of relay or reserve capacity required to insure continuous service, and the diversity of demand.

Industrial plants have a load factor under ordinary operating conditions less than 25 per cent, while a well-developed utility system reaches 40 per cent or even higher. The average fuel consumption in utility plants is not far from two pounds per kilowatt-hour, and the largest and most modern plants use but little more than one pound of coal. It is difficult to secure figures for the fuel economy of industrial plants, but from the data available it appears safe to say that industrial plants will require two or more times the amount of coal per kilowatt-hour used by a utility plant. The labor cost and the incidental expenses of operation and maintenance per unit of output in a large plant are less than such costs in a smaller plant. Utility plants can be located more favorably with respect to condensing-water supply and fuel than can industrial plants. All these factors are favorable to low comparative power operating cost for the utility.

Many industrial plant managers recognize that if they did not have a large existing investment in power facilities, it would be advisable to purchase utility power. The duplication of spare capacity has been eliminated in some cases by the supply of so-called "unrelayed" service. Such service is furnished by utility plant equipment that is normally held in reserve. When this must be used in regular utility service the industrial customer is called upon to operate his own plant for a limited period. Such service involves lower cost to the utility because of the reduced investment required, and may be attractive to industrial customers.

The rapid growth of utility plants, their interconnection over large areas, the advantages of reduced relay capacity and the continuous operation of the most efficient units of the system all point to further reduction in the cost of utility power and its favorable comparison with independent industrial plants. Power development in this country has reached limits far exceeding those of any other country. This has contributed largely to our national prosperity and the comforts and advantages enjoyed by our industrial workers.

Power for Textile Mills

"Power for Textile Mills" was considered by Charles T. Main, past-president, A.S.M.E. After a detailed study of the cost of generating power in a small steam plant, Mr. Main said that it has long been common practice to use exhaust steam and steam from the receivers of compound engines for manufacturing purposes and for heating buildings.

The saving by the use of exhaust steam is considerable. In some mills if power were not produced by steam, with the low-pressure steam used for

manufacturing purposes, it would be necessary to maintain a boiler plant to produce an equivalent amount of steam.

The bleeder type of steam turbine lends itself to this manner of running better than the reciprocating steam engine and supplies steam free from oil for process work.

A study of water-power costs shows the effect of variable water flow on the cost, due to the necessity of a supplementary and stand-by plant. If considerable quantities of steam or warm water can be used in the manufacturing processes, the amount that can be invested in water power is less.

Mr. Main presented figures showing how much a mill can afford to pay for purchased power under various circumstances, and summarized his conclusions by saying that old water powers should be remodeled with increased capacity, that when much hot water or process steam is needed steam-power generation is usually cheaper, while in other cases it may prove cheaper to buy power.

The Paper Industry

In discussing "Power for the Paper Industry," Joseph Warren, vice-president of the S. D. Warren Co., a manufacturer of book paper, dealt largely with paper-making statistics and processes.

A book mill, making its own pulp, will require power and steam per ton of paper about as shown by the following table:

	Kw. per Ton per Day	Steam per Ton
Pulp mills:		
Cooking	6.3	6,000
Evaporating	...	4,200
Beaters	21.0	....
Machines	2.5	6,000
Drying	...	1,570
Miscellaneous	3.0	1,080
Electrolytic	5.2	1,300
Radiation	...	3,850
	38.0	24,000

With the efficiency of modern turbines and the practicability of generating steam at high pressures, there is an opportunity for the generation of byproduct power. Much steam is utilized for drying, requiring but a few pounds pressure. The passage of this steam through a turbine, reducing, say, from 200 lb., superheated, to 10 lb. exhaust, will yield nearly one-half of all the power required. Still more could be obtained from steam at higher pressures.

The Small Plant

The concluding paper of the day was, "Power for Industries Using Relatively Small Amounts of Power," by K. D. Hamilton, of the Geo. E. Keith Co., Brockton, Mass. Among the industries of New England are many plants able to operate at moderate cost through the installation of new equipment. They use turbine generators or 4-valve or unaflow engines. High efficiencies are maintained through the use of economizers, stokers, the latest types of boilers, coal- and ash-handling machinery and, above all, efficient management.

On the other hand, there are found some establishments with old equipment, badly maintained and carelessly operated.

No matter how poor the layout is, proper supervision, reasonable expenditure for equipment and above all things co-operation by the management can make the so-called inefficient plant produce power and steam at reasonable figures. If one has a large use for exhaust steam, he can produce power at a lower cost than he can purchase it. Plants that have no balance between steam demand and power may find that it is cheaper to buy their power. New England has a heating load for six to eight months besides demand for process steam, and plants must maintain a boiler plant anyhow. The slight additional cost for generating equipment will in many cases warrant its expenditure.

His conclusions are that steam power can be produced in New England in competition with the central station, provided there is a balance between power and steam requirements and wise use of the power generated.

High Steam Pressures

The Friday morning session was presided over by I. E. Moultrop, vice-president of the Edison Electric Illuminating Co. of Boston. The first paper was presented by Joseph Pope, of Stone & Webster, upon the "Advantages and Disadvantages of the Use of High Steam Pressures (in Excess of 200 lb. per sq.in.) in Industrial Plants," by which Mr. Pope means plants using power and requiring steam for heating or process. When the power needed is more than can be generated with the steam sufficient for process use, higher initial pressure is of particular interest, for thereby more power is obtainable from the same quantity of steam. The gains are naturally greater for a plant having high back pressure for process use.

The use of high steam pressures involves the use of heavier equipment, but in some cases apparatus of less capacity may be used and thus partly compensate for the additional cost. However, in the industrial plant the need is usually for a given quantity of steam for process work, and advantage of the lower water rate of the high-pressure prime mover is taken not to reduce the boiler sizes, but rather to increase the turbine size.

Mr. Pope thinks that equipment affected by the steam pressure costs about 40 per cent more for 400 lb. working pressure than for 200 lb. There are, of course, many items of steam plant equipment unaffected by the steam pressure.

Operation at higher pressure demands close attention to the quality of boiler-feed water, said Mr. Pope, and it may be that the use of a high pressure will carry with it the need for a water-purification process or an evaporator plant of considerable size.

He discussed the difficulties of selling surplus industrial power to a utility, pointing out that the selling price must be very low and the reliability safeguarded.

In conclusion Mr. Pope said that high steam pressure can be shown to be advantageous in some industries but not in others, and that even in the industries where the conditions are generally favorable, it may not be suitable in all plants. The use of extremely high pressure should, he advised, be undertaken only with great caution.

It must also be remembered that after the engineer has figured and planned with the utmost care and has demonstrated that an investment in high-pressure equipment can be made to pay high returns, the management may prefer to spend the same sum in productive departments of the industry or on a sales campaign whereby even greater returns will be obtained.

Charles T. Main said in discussion that the central station, whose product is power, can afford greater expense for efficiency than the average industrial plant for which the cost of power is only an incidental. The first requirement of the industrial plant is reliability and simplicity.

F. S. Clark, of Stone & Webster, said that interconnection between central stations gives reliability. The percentage of purchased power is constantly increasing. The money invested in a private power plant can be invested in other parts of the business and give greater returns.

Mr. Powell judged from inquiries that came to them that higher pressures were regarded rather lightly. Having gone from 100 to 200, it seems a small matter to jump to 500 or 600, but the gain is often assumed to be in simple arithmetical proportion.

F. M. Gibson pointed out that production is limited by sales and not by the capacity of the plant. A given saving in the power plant may be a considerable percentage of the profits. One plant that he knew of burns 1,000 tons of coal a day.

W. G. Diman, of the Amoskeag Manufacturing Co., mentioned the difficulty when high-pressure steam is passed through a turbine and exhausted at high back pressure for process work, that comes from the turbine losing its load. No reducing valve will take care of the large amount of steam involved and such steam, uncooled by doing work by expansion, may be ruinous to the processes.

Alfred Idell, of the Babcock & Wilcox Co., said that they had about 400,000 hp. of boilers for 350 lb. and over, of which some 60,000 hp. was for 650 lb. and above. Prominent industrial plants have been buying boilers for 250 and 350 lb. They have an order for a 1,200-lb. boiler for a paper mill in Mississippi.

Extraction Steam Heating

The paper on "Utilization of Extraction Steam," by Edgar A. Dickinson, R. G. Standerwick and A. D. Somers, of the General Electric Co., was an exhaustive consideration illustrated by detailed descriptions of the types of turbines available for various conditions, and does not permit of presentation in abstract. *Power* hopes to reproduce it, in part at least, in a future issue.

W. G. Starkweather asked if the operating man was "up to" all this complication of wonderful mechanism. Can they take advantage of all this refinement? He knew of cases where back-pressure and extraction turbines

had been put in and not used, because the operating men did not know how to get the good out of them.

P. W. Foster, of the Power Specialty Co., spoke of the difficulty of getting dyehouse and other foremen to use exhaust steam. They insist upon 100-lb. live steam, and rather than lose their services or give them an excuse for damaged work, managers let them have it. One engineer changed the gage to read 100 lb. when there was but 25 on, and the dyer never knew the difference.

Mr. Dickinson, in closing, said he had no fear for the future. There were many operating engineers who could give the manufacturer cards and spades on handling machinery. He made an urgent plea for exact data.

The Friday afternoon session was presided over by F. N. Gibson, plant engineer of the American Sugar Refinery and chairman of the Affiliated Technical Societies of Boston. The only paper presented was that by W. H. Larkin, Jr., power engineer, General Division U. S. Rubber Co., on "The Supply of Industrial Power." This paper was the same as that recently presented by Mr. Larkin at the recent annual meeting of the American Society of Mechanical Engineers and was abstracted in the Dec. 15 issue of *Power*.

Mr. Fitch, of the Dennison Manufacturing Co., described the reorganization of that plant, illustrated by lantern slides.

F. M. Gibson exhibited slides showing the relation of the heat demand to the power load in various industrial plants. The rest of the afternoon was devoted to a round-table discussion which space and time do not allow us to reproduce here.

Urges Substitutes for Anthracite

In the evening a dinner in the large banquet hall of the Boston Chamber of Commerce was participated in by between 350 and 400 persons. The theme of the addresses was the anthracite shortage and how to meet it. Eugene C. Hultman, chairman of the Special Commission on the Necessities of Life of the Commonwealth of Massachusetts and vice-chairman of the New England Governors' Fuel Committee, made an earnest plea for a consumers' strike against the use of anthracite, the "luxury fuel," and urged the use of low-volatile bituminous. Homer R. Linn, engineer, American Radiator Co., gave some amusing and instructive experiences with and advice upon the use of house-heating equipment. A resolution of sympathy for Leonard Metcalf, who is seriously ill, was adopted with expressions of appreciation of his leadership in the founding of the Affiliation. Louis E. Moore, of the Civil Engineers, made an excellent toastmaster.

Practical Refrigerating Engineers Meet in Detroit

FROM December 8 to 12 the National Association of Practical Refrigerating Engineers met at the Hotel Statler, Detroit, for the sixteenth annual convention. With more than 700 registered, the meeting was a decided success. A full program on a wide diversity of subjects had been arranged, and the "question box" provided an ever ready source for practical discussion at opportune moments. Of supplementary educational value was a mechanical exhibit aggregating some fifty booths in which the latest refrigerating and ice-plant specialties were on display. Prearranged inspection trips were made to the River Rouge plant of the Ford Motor Company and to the plant of Dodge Brothers. Entertainment, in addition to that provided daily for the ladies, consisted of the annual banquet and on the following evening a Michigan Mardi Gras with a variety program.

An event of great import to the association was the complete revision of the constitution and bylaws. At the last convention a committee had been appointed to draw up the new regulations, and the results of their efforts, presented in tentative form, were approved after an all-night session and further consideration on the final day of the meeting. Final adoption will be subject to the action of all chapters and members at large, a majority of two-thirds being required.

In his address at the opening session President Ormsby emphasized the importance of specialization in engineering work and among engineers generally the need of a broader vision. The success of a refrigerating engineer depends on his knowledge of machinery and heat transfer, the anticipation of difficulties and his ability to handle men as well as to obtain the whole-hearted co-operation of the management.

That the association had served its members and the refrigerating industry better than ever before was the opening statement of the secretary's report. Mr. Fox attributed this to the educational fund which had made it possible to put into effect a broad program of which the association's lecture course was the foundation. This had been augmented by supplemental lectures, lantern-slide lectures and numerous bulletins. All except four of the 31 chapters of the association were functioning satisfactorily. During the year there had been a net gain in membership of 245, bringing the total to 2,611. The treasurer, Charles W. Chapman, gave the total receipts for the year $8,118.20 and the disbursements as $7,769.74, leaving a balance of $348.46.

A report made by the board of directors showed that the association was represented, either by local chapters or by members at large, in all but seven of the 48 States of the Union. Provision in the constitution for the formation of chapters in foreign countries was recommended.

To provide for expansion in the way of organizing new chapters and increasing the members-at-large, the board of advisors, rather than raising the annual dues of $6.50, presented a resolution calling for a registration fee of $2.50 at all future conventions, the total realized to be placed in the general fund of the association.

In an interesting report the committee on engine-room records listed the items that should be considered and by means of slides illustrated typical forms that would give the efficiency of operation and the cost of production.

The technical program covered a wide range of subjects featuring operation and design and by way of diversity two motion pictures of unusual interest, one illustrating oxyacetylene welding and cutting followed by liquid-oxygen demonstrations, and the other showing the manufacture of steel pipe.

Under the subject of "Efficient Operation of Refrigerating Power Plants," Victor J. Azbe pointed out the limits of plant efficiency, the practically possible ranges of pressures and temperatures, the power requirements and the conditions affecting heat transfer in the ice tank. An interesting feature was his graphical method of studying plant performance by using temperature diagrams to visualize the losses. Discussion turned to the amount of condenser water pumped per ton of ice, temperature differences between water and ammonia, the variation between summer and winter conditions, brine velocities and the surface installed in brine tanks.

As a matter of general interest E. J. McCormick summarized for the convention the engineers' license laws of the City of New York. A feature for a steam-driven refrigerating plant was the dual requirement of licenses, one for operating a steam plant and the other for operating the refrigerating plant. With motor drive only the refrigerating license was required.

Plant Management

In a paper dealing with plant management, James E. Peterman outlined the qualifications that should be possessed by the operating force and the policy of the management. The speaker made brief reference to station logs, the purchase of supplies and accessories, and reduction of costs by co-operation between the management and the engineer. In a well-managed plant the four factors requiring close attention were: condition of the ammonia compressor, non-condensible gases in the system, lubrication and cleanliness of the plant. In the concluding remarks some excellent pointers were given on how the employee might make himself more valuable.

An instructive paper on "Construction and Operation of Ice Storage Houses," by R. C. Doremus, drew an interesting comparison of the principal types of house in use, including construction details, methods of operation, coil arrangement, locations of tank-room and mechanical equipment.

To secure the most economical operation, the practical refrigerating engineer must understand the science of the

profession, know its best practices and have the ability to apply skillfully his knowledge. These were the assertions of H. G. Vanemann, in his paper on "Engineering and Maintenance of Ice Making and Refrigerating Plants." The engineer's first duty was to keep the machinery and equipment in the highest state of physical perfection; his second duty was to operate and produce the best results with that equipment on the least expenditure of money, and the third and most important part of the job was to conceive plans for improvement and extension of the plant. The first required mechanical ability, the second executive qualifications and the third ingenuity combined with a knowledge of engineering and design. An engineer might be skillful and proficient in the first two duties, but his success and his salary would be determined by his performance of the duty last named.

Compressor Efficiency

In treating the subject of "Compressor Efficiency and Factors Which Affect It," J. H. H. Voss stated that the indicated compressor efficiency was influenced by so many factors that it was desirable for the practical engineer to have guides showing him how to apply systematically established rules resulting in improvement of plant operation. To show what the ammonia did and to give its pressure and temperature conditions, the speaker utilized Dr. Doederleius' heat-flow, pressure and temperature graphs, tracing each step of the cycle. Professor Stetefeld's indicator-card analysis was used to show how the practical indicator diagram develops from the theoretical diagram. Prof. G. Lehnert's fourteen indicator diagrams were incorporated to illustrate how the indicator shows mistakes in design, maintenance and operation. Indicator cards from poppet-valve and plate-valve compressors were presented to show that the advantages were with the latter type of valve, instead of the reverse, as had been advanced at the convention a year ago. As the speaker pointed out, the diagrams showed that the old theory of the non-clearance ammonia compressor finally had been exploded. It was not the volume that counted, but the amount of heat that the ammonia carried, and it has been recognized that saturated ammonia gas carries more heat than superheated gas, which is always present in the non-clearance compressor.

In the discussion some attention was given to the opening pressures and the areas of the two types of valve.

A brief paper by R. H. Switzler, president of the American Association of Ice and Refrigeration, summarized the activities of this body which formed an important niche in the ice-making industry.

Ice-Freezing Tanks

Under the topic, "Construction and Operation of Ice Freezing Tanks," Harry Sloan traced the improvements from the early days up to the time when construction became standard and remained so for ten or twelve years. With the introduction of raw-water ice and the multiple lift of from 4 to 28 cans at a time, designs became varied to the disadvantage of the ice manufacturer, because of the greater cost of designing each plant to meet specific conditions. The speaker pointed out how different freezing rates with 11- and 11½-in. cans affected suction pressures and the economy of operation. A number of slides were used to illustrate methods of construction for the multiple lifting of cans and systems of air agitation. Evaporating systems, including brine coolers and tank coils, were discussed; also the economy of better heat transfer and the methods of obtaining it.

Arthur C. White spoke of the research work that the Dow Chemical Company had been conducting on the corrosion of metals used in ice plants. This had been confined largely to the action of calcium-chloride solutions on iron and zinc-coated iron. Early in the work it had been recognized that certain products of decomposition or corrosion acted as inhibitors in themselves by forming more or less protective coatings or films on the metal, and furthermore that the character of these films could be varied over a wide range. This quality seemed to be particularly characteristic of zinc and was one reason why galvanizing had been so widely used. For the same reason it had been found that strong-gravity brines of high alkalinity tended to corrode iron much less than do those of lower specific gravities and alkalinities. The addition of lime or a caustic-soda solution to such brines as a means of controlling the alkalinity was recommended. In the field of so-called inhibitors to prevent electrolytic action, mention was made of the use of chromium salts and zinc chloride. Discussion developed on the use of caustic soda and certain patented compounds in brine.

John A. Hopkins listed a number of handy tools for the refrigerating plant and briefly touched upon the important instruments for supplying operating data and their uses.

Condensers from Engineer's Viewpoint

Condensers from the engineer's viewpoint was the subject allotted to H. J. Halterman, who discussed the main types of ammonia condenser, including atmospheric, bleeder, double-pipe, multi-tube and shell-and-tube types, emphasizing the importance of their proper care and operation. Points to be considered in the choice of a condenser were enumerated and attention given to methods of removing scale and the disposition of foreign gases. Discussion turned to methods of cleaning the tube surface by the use of brushes, turbine cleaners, special compounds and an air line connected to the bottom tube of a surface condenser to blow out the mud.

The salient features of new electrical equipment for ice making and refrigeration were covered in a paper by H. P. Hill. Particular attention was given to the development of the synchronous motor and its advantages as a direct drive for the compressor. The author enlarged upon the operation and maintenance of these machines, of transformers, the switchboard, oil switches and the control equipment.

"Lubrication in Refrigerating Plants with Compression Type Machines," by Thomas M. Gunn, of the Vacuum Oil Co., was a paper received with interest. The author enumerated the different kinds of refrigerants in use, but centered his remarks on ammonia and carbon-dioxide machines. Proper lubrication of refrigerating machinery was doubly important, as not only wear and leakage were to be considered, but also the possibility of obstructing various parts of the system to the detriment of economy and capacity.

Oil suitable for refrigerating machinery should have a low pour test, chemical stability, sufficient body to maintain the lubricating and sealing oil film at cylinder temperature and be homogeneous. In certain types of construction the oil must be suitable for both cylinder and bearing lubrication, and where splash and circulating systems were used, the oil must have a high degree of purity. High lubricating value was one of the leading requirements. The author reviewed the consequences that would follow the use of an unsuitable oil, methods of oil application, provisions for draining from the system and the use of purifiers and filters. Mention was made of an initial period of trouble even when the correct high-grade oil is installed, owing to the cutting out by the new lubricant of gummy deposits left by the oil formerly used. Keeping oil out of the ice was another problem touched upon.

Car Icing Stations

G. G. Wall, who is superintendent of the refrigeration department of the Pacific Fruit Express Co., talked on the "Operation and Management of Car Icing Stations." Attention was given to numerous points important for the efficient operation of artificial plants, to the operation of condensers, liquid coolers, regenerators and other equipment of the refrigerating and steam plants, the requirements of natural-ice plants and icing platforms and to safety considerations. By a series of excellent slides Mr. Wall showed the arrangement and equipment of typical plants, the tools used, steam and motor drives for compressors and in particular the various types of conveyor employed. There was brief discussion on gravity handling of ice and on types of lugs used on the conveyors.

At the final session the following officers were elected: President, Charles W. Chapman, of Detroit; first vice-president, Basil S. T. Dobree, of New Orleans; second vice-president, Fred I. McCanlish, of Kansas City; secretary, Edward W. Fox, of Chicago; treasurer, A. B. Martin, of Dallas, Tex.; sergeant at arms, W. C. Reinhard, of Houston, Tex.; Board of Directors, F. B. Fulmer, of Oakland, Cal.; James Spaulding, of Memphis, Tenn., and George A. Pardee, of Louisville, Ky.; chairman of Board of Education, H. R. Halterman, of Chicago; chairman of Committee on Standards, Van H. R. Greene, of New York City; chairman of Committee on Engine Room Records, A. J. Authenreith, of Chicago; chairman of Committee on exhibits, C. L. Whittemore, of St. Louis.

Kansas City was selected as the next convention city.

Power a Part of River and Harbor Improvement Plan

Completion within five years of all authorized river and harbor projects was urged upon the President, the Vice-President, the Speaker of the House of Representatives and the chairman of the Appropriations Committees by a committee of forty prominent persons selected from those in attendance last week at the convention in Washington of the National Rivers and Harbors Congress. The President spoke so favorably of waterway development that Representative Riley J. Wilson, the president of the Rivers and Harbors Congress, on leaving the White House said that "inland waterways never before have had such a friend in the White House as is Calvin Coolidge."

From Washington comes the information that some $200,000,000 worth of river and harbor improvements have been authorized, but appropriations have lagged behind. The budget carries $40,000,000 for river and harbor projects, but the President has indicated that he will approve a deficiency appropriation if it becomes evident that more money can be spent to advantage during the next fiscal year.

In a formal resolution the Rivers and Harbors Congress went on record favoring general surveys under the direction of the Chief of Engineers, of all navigable streams "not only for navigation improvement but for power development, flood prevention and reclamation by irrigation and drainage."

Delaware River Compact Meets Further Opposition

General opposition to the proposed Delaware River compact for the diversion of water and the power resources of the river among the states of Pennsylvania, New York and New Jersey met with opposition at the hearings in Harrisburg recently. Objection was chiefly directed to the fact that New York City would get large quantities of water from the Delaware watershed, although that city is not in the river basin. The hearing, according to press reports, made fairly certain that the compact which the 1925 Legislature of Pennsylvania refused to approve, will need to be amended in various ways.

Babcock & Wilcox Co. Has Purchased Fuller-Lehigh and Bailey Meter Companies

Col. Fuller to Be Chairman of Board of Fuller-Lehigh, Mr. Bailey Becomes President of Fuller-Lehigh Co. and Bailey Meter Co.

THE Babcock & Wilcox Co. announces that it has purchased the Fuller-Lehigh Co. and its subsidiaries, manufacturers of pulverized-fuel and cement-mill equipment; also that it has purchased the Bailey Meter Co., manufacturers of meters and recorders, combustion-control equipment, pulverized-fuel feeders and water-cooled furnace walls. The Fuller-Lehigh Co., and the Bailey Meter Co. will be operated with the same organizations as heretofore, with the exception that Col. J. W. Fuller will become chairman of the board of the Fuller-Lehigh Co., E. G. Bailey will become president, and A. E. Douglass, of Fuller-Lehigh Co., will become vice-president in charge of sales. Mr. Bailey will continue to act as president of the Bailey Meter Co., and R. S. Coffin will continue as vice-president and general manager.

By the acquisition of these companies the Babcock & Wilcox Co. will be able to offer boilers, superheaters, economizers, air heaters, chain-grate stokers, oil burners, pulverized-fuel equipment, water-cooled furnace walls, meters, and combustion-control equipment; all in any combination that may be required to supply complete steam generating units.

Coal Operators and Miners Asked to Meet on Dec. 23

Representatives of the coal operators and anthracite miners were asked to resume their strike settlement negotiations at Scranton, Dec. 23, in a resolution adopted on Dec. 16 by the Mayors and Burgesses of the hard-coal regions, meeting with Governor Pinchot at Harrisburg.

Anthracite operators meeting at Harrisburg on Dec. 16 accepted the plan drafted by seven legislators of Luzerne County for the termination of the suspension in the anthracite industry.

John L. Lewis, president of the United Mine Workers of America, rejected the proposal flatly, characterizing it as "simply the operators' plan wrapped in a new package."

According to opinion in Washington, Congress is not likely to act on the strike problem until at least the Pennsylvania legislation shall have had an opportunity to meet the situation.

National Engineering Museum Wants Reminiscences

In accordance with an invitation extended by the National Museum of Engineering and Industry, 29 West 39th St., to several societies, many of whose members had joined it individually, to nominate representatives to its Board of Trustees, the Four National Engineering Societies, American Association for the Advancement of Science, American Chemical Society and the Society for the Promotion of Engineering Education, have responded favorably and are now represented on its Board, which is constituted as follows: Samuel Insull, chairman; L. P. Alford, A.S.M.E.; B. C. Batcheller, Nicholas E. Brady; F. H. Colvin; Norman Dodge; Gano Dunn, A.I.E.E.; Col. A. S. Dwight, A.I.M. & M.E.; Thomas Ewing; John R. Freeman, A.S.C.E.; Col. Michael Friedsam; Major H. A. Gillis; Henry Goldmark; Frederick A. Halsey; Dugald C. Jackson, S.P.E.E.; Luis Jackson; Dr. F. B. Jewett, A.I.E.E.; John W. Lieb; Fred R. Low, A.S.M.E.; W. W. Macon; L. C. Marburg; H. P. Merriman; M. I. Pupin, A.A.A.S.; W. L. Saunders, A.I.M. & M.E.; J. Waldo Smith; Dr. Elmer A. Sperry, American Chemical Society.

Many of its members have donated to the museum original historical documents, old patent records, books, drawings, prints, models, photographs and description of important work, etc., and correspondence regarding such things is solicited.

In this connection the secretary says that he has for some years been collecting reminiscences not only by eminent men regarding some of their accomplishments which have not been previously recorded, but by others who may not have had such opportunities at all.

For instance, recently, a member of the A.S.M.E. told of having called in 1889 on James Nasmyth, the inventor of the steam hammer and many other notable mechanisms, at his home in Kent and the latter recounted to him his experience with James Watt, who invented the steam engine in 1769.

The relating of occurrences of a similar character will be most acceptable and may result in the publication later of material that would not otherwise see the light. Such reminiscences may be of great value if recorded, and the time to record them is now before they are forgotten or their possessors pass away. The secretary, H. F. J. Porter, would like to hear by letter from anyone recounting items of historical interest, or if they should happen to be in the neighborhood of his office, 29 West 39th St., New York City, he would welcome a call.

Secretary Hoover Advocates Congressional Committee to Hasten Colorado River Development

E. C. LaRue Points Out the Necessity for a Treaty With Mexico Now—Senator Pittman Proposes Licenses on Colorado Be Suspended Until 1928

AGREEMENT among the states of the Colorado River Basin that would permit the development of the resources of the river might be hastened, Secretary Hoover has told the Senate Committee on Irrigation and Reclamation, which has before it the Swing-Johnson bill, were a Congressional commission appointed for that sole purpose. Secretary Hoover, in his testimony before the committee, used as a basis for his remarks the estimate which puts the cost of the Boulder Dam at $42,000,000 for construction, $33,000,000 for electrical equipment, and $27,000,000 for transmission lines. The aggregate of the various other items would make the cost of the project $115,000,000. Mr. Hoover told the Committee:

> The people of southern California recognize that the Eastern and Central States probably will not be anxious to find the whole $115,000,000 for this development. The Californians, however, have expressed their willingness to make a substantial contribution to it coming from the municipalities and the private power companies. The federal government has a substantial obligation in connection with the development.
>
> Someone ought to be given authority to negotiate a definite financial contract which could be laid before Congress for ratification. It possibly could be brought forward at this session of Congress. I believe we should do all we can to expedite this matter. Our path would have been smoother had the Colorado River compact been ratified, but where we have such wide differences of view we must expect difficulties. It took ten years to secure the ratification of the federal constitution, and I doubt if there were as much emotion connected with that ratification as there is in the matter of water rights.
>
> The federal government will not want to build electric works there and get into the power business. There have been some discussions in southern California of an arrangement between the municipalities and the private power companies. I do not know how far they have gone, but it ought to be possible to bring some conclusion out of that.

E. C. LaRue, a hydraulic engineer in the service of the Geological Survey, discussed the disadvantages of increasing the lower water flow of the river at this time. Among other things he said:

> If you construct the Boulder Dam so as to develop 500,000 hp., you will have regulated the river and will have increased the low water flow to such an extent that it will be far beyond the needs for irrigation for many years to come. The increase in the low water flow will pass into Mexico. There will be 800,000 or 1,000,000 acres irrigated in that country with the water which we will not be using. When it comes to a division of the water, it will have been put to beneficial use in Mexico. In my opinion the United States never will dispossess those lands of water without paying for them.
>
> We should try to get Mexico to enter into a treaty now—not ten years from now. If they do not meet us halfway, they will have no complaint in later years if we take the water away by diverting it in this country. Most of the land in Mexico is owned by American citizens, and they are shrewd enough to accept this Boulder Canyon Dam.

So as to make sure that no license for water-power development will be granted on the Colorado River until the states in the basin come to an agreement, Senator Pittman, of Nevada, has introduced a joint resolution proposing that the authority of the Federal Power Commission to issue licenses covering projects on the Colorado be suspended until Feb. 1, 1928.

In the preamble of his resolution Senator Pittman points out that action by the Commission before ratification of a compact by all the states "would embarrass the consummation of the plan" and would "endanger the consummation of a national policy for the co-ordinated development of the entire river and its tributaries and the highest use of its waters."

New Muscle Shoals Commission Not Yet Authorized

A determined effort to induce the rules committee of the House of Representatives to act on the Madden resolution proposing a Muscle Shoals Commission, seems to have failed. Chairman Snell of that committee is the author of another bill proposing a commission along the lines suggested in the President's message. As this is written, the expected meeting has not materialized, and it now is understood that no meeting of the rules committee is likely to be called until after the Holiday. Opinion still is divided as to the prospect of Muscle Shoals legislation at this session. Some are of the opinion that nothing will be done, while others think a joint committee of Congress will be authorized to call for bids. The disposition to circumscribe the type of bid that may be made promises to make it difficult to get through even that form of legislation.

Bureau of Mines Is Studying Scale Formation in Boilers

The purpose of an investigation being conducted at the Pittsburgh Experiment Station of the Bureau of Mines, is to determine whether the character of the precipitates forming in boilers may be made to assume a form in which they do not attach themselves to the walls; and if the material in the boiler wall exercises any influence. Data have been obtained on the non-condensible gases which are carried off in the steam, and the correct relationships to be maintained when carbonate becomes unstable and phosphate must be used in boiler-water conditioning. The use of phosphate may form objectionable deposits. This condition is being looked into. Further, indicators used in titrating boiler waters do not necessarily represent the true phosphate or carbonate concentration. Means of controlling this indication are being investigated. Conditions that may bear on wet steam are being watched in the hope that definite information may be acquired on the factors influential in wet steam development and thereby control be obtained over them.

Midwest Power Conference To Be Held Jan. 26-29

Plans for the Midwest Power Conference, which is to be held in Chicago from Jan. 26 to 29, 1926, at the Furniture Club of America, are progressing and practically the entire program now may be definitely announced. It will be recalled that the conference is to be held under the auspices of six different associations as follows: Group 5 of the American Society of Mechanical Engineers, the Great Lakes Division of the National Electric Light Association, the Chicago Section of the American Institute of Electrical Engineers and the American Institute of Mining Engineers, National Safety Council and the Western Society of Engineers. It will deal with the larger aspects of power generation by steam and water, the modern trends leading to higher economies in both the central station and the industrial plant and a final session on oil and gas power.

The program in detail is as follows:

Tuesday morning—Registration.

Tuesday afternoon—W. L. Abbott, chairman. Address by Samuel Insull, "Some Comments on the Power Developments of the Mississippi Valley."

Wednesday morning—B. F. Lyons, chairman. "What We Can Expect from Hydraulic Power in the Middle West," by Daniel W. Mead; "Changing Viewpoints in Hydraulic Turbine Practice," by H. Birchard Taylor; "Superpower in the North Central States," by R. F. Schuchardt; "Rural Electric Service," by G. C. Neff.

Wednesday afternoon—Homer E. Niesz, chairman. "Recent Developments in Electric Power in the Chicago District," by William S. Monroe; "Present Practice in the Burning of Pulverized Fuel," by C. F. Hirchfeld; "Byproduct Processing of Coal," by H. W. Brooks; "Boiler Water Conditioning, with Special Reference to High Operating Pressure," by Dr. R. E. Hall.

Thursday morning—James E. Herron, chairman. "Layout and Equipment of Industrial Power Plants," by Paul L. Battey; "A Machine for Testing Steam-Turbine Nozzles by the Reaction Method," by G. B. Warren and J. H. Keenan; "Safety and First Aid in Industrial Plants," by C. B. Scott; demonstration of first aid by a team from a Chicago organization; "Planning and Operating Industrial Hydraulic Plants for Best Economy," by L. F. Harza; "Purchased Power for Coal Mines in Illinois," by J. Paul Clayton.

Thursday afternoon—Inspection trips to the Crawford Avenue Plant of the Commonwealth Edison Co., the printing plant of the *Chicago Tribune* and the Underwriters' Laboratory.

Thursday evenning—Dinner Meeting—The subject will be "The Effect of Wide Power Distribution and Availability on the Social and Economical Life of the Country and the Most Desirable Methods of Promoting and Controlling Such Development in the Hands of Private Enterprise." Arrangements are under way to have speakers of national reputation.

Friday morning—A. A. Potter, chairman. "The Diesel Engine in the Industries," by Max Rotter; "Diesel-Electric Locomotive, Its Present Status and Performance and Its Future Possibilities," by Samuel M. Vauclain, president of the Baldwin Locomotive Works; "The Economics of Oil as a Boiler Fuel," by Allen E. Brewer; "Present Status of Byproduct Gas Furnace Practice," by H. H. Clark.

Friday afternoon—Group inspection trips will be arranged as desired to plants of interest. Plants that visitors may like to see are the Western Electric plant at Hawthorne, the new plant of the International Harvester Co., Chicago Avenue Pumping Station and the Chicago Stock Yards.

Soot Removal and Prevention Compounds Being Studied

A study of soot removal and prevention compounds is being made by the Bureau of Mines. In order to determine the effectiveness of such compounds for their stated purposes, a study is being made of the flue-gas temperatures and gas composition necessary for the reactions to take place both with and without the use of the compounds or other materials. The investigation will be extended to a study of the effectiveness of the compounds under conditions similar to those to which they are supposed to be applied.

Government Sells Power and Pumping Plant

On Nov. 20 the Secretary of the Interior sold the Williston reclamation project, Williston, N. D., for $151,388 to the United Power Co., of Crosby, N. D., the highest bidder. The sale price to be paid in 20 installments with 6 per cent interest and the purchaser will also pay 20c. royalty per ton for coal mined from the government coal mine connected with the power plant. The project, which consists mainly of a power and pumping plant, cost about $470,000, of which none has been repaid.

Chicago May Celebrate Its 100th Anniversary with Fair

A world's fair more ambitious than the Columbian exposition to celebrate Chicago's 100th birthday was urged upon the City Council recently by Mayor Dever.

It was proposed to have the centennial in 1933, 100 years from the time when Chicago was incorporated as a village, or in 1937, a century from the time its charter as a city was obtained.

The exposition would be different from the World's Columbian exposition, which had exhibits representing the people of foreign countries. The domestic as well as foreign participation would be by municipalities rather than by races or nations.

Tom Lee, Negro Hero, Gets Reward

When the Mississippi River government boat the "M. E. Norman" turned turtle precipitating the visitors attending the Mid-South Engineers convention, who were on an inspection trip, into the river, Tom Lee, a negro boatman, played the part of hero. The disaster was described in *Power*, May 19, 1925, page 809.

Of the sixty-seven people who were rescued, Tom saved thirty-two. The Engineers' Club of Memphis and the Memphis *Commercial Appeal*, collected a fund for Tom which amounted to $4,000. Out of this was purchased a home for him, costing $2,700, and an annuity for taxes, etc., was established. Tom moved in early in November. The cottage is on a plot of ground 90x100 ft. and has a good garden with plenty of room for chickens. Permanent trustees, survivors of the "Norman," have been appointed to look after Tom and his house.

60 Per Cent of Engineering Students Drop Out

Progress of an investigation of engineering education, it is reported in the press, which is being conducted by 160 engineering schools with the cooperation of the technical industries, professional societies and the United States Bureau of Education, was reported on Dec. 8 at a meeting at Yale University by William E. Wickenden, director, and Harry P. Hammond.

In the engineering schools of the country 60 per cent of those entering as freshmen do not graduate, according to the report. This is true although the freshmen have been honor students, or with trivial exception had a standing in the upper two-thirds of their high school classes. The chief reasons for elimination were said to be poor preparation in the high schools, a lack of effective guidance in the selection of a career, and failure on the part of the colleges to deal properly with the student after admission. It was found that among the fathers of freshmen only one-eighth have college degrees and that one-sixth have had less than a grammar school education.

The decision to study engineering was made before the last year of high school by 50 per cent and during the last year by 27 per cent, the speakers said. It has been found that of the students in the freshman year more than a half had little or poor conception of the field of engineering.

A.I.E.E. Nominating Committee Announces Candidates

The nominating committee of the A.I.E.E. has named the following official ticket of candidates for the offices falling vacant Aug. 1, 1926: For president, Cummings C. Chesney, G. E. Co. Vice-presidents, H. M. Hobart, G. E. Co.; G. L. Knight, Brooklyn Edison Co.; B. J. Jamieson, Commonwealth Edison Co.; A. E. Bettis, Kansas City Power & Light Co.; H. H. Schoolfield, Pacific Power & Light Co. Managers, F. J. Chesterman, Bell Telephone Co.; H. C. Don Carlos, Hydro-Electric Power Commission of Ontario; I. E. Moultrop, Edison Electric Illuminating Co. of Boston. Treasurer, G. A. Hamilton, Elizabeth, N. J.

Two Power Companies Have Withdrawn Applications for Tennessee River Dam Sites

Analysis of the Report on Survey of Tennessee River Was Made Public by Major Fiske on Dec. 12 — Senator McKellar Objects to Giving Licensees Information Ahead of Congress

HEARINGS on the projected developments of the Tennessee River and its tributaries, where 4,000,000 hp., it is thought, can be developed above Muscle Shoals, were held on Dec. 15 at Chattanooga by Major Harold Fiske of the Engineers Corps of the War Department, and chief of the power survey of the Tennessee Valley. The advance publication of the potentialities of the project in the *New York Times*, Dec. 13, developed some vigorous opposition from Senator McKellar of Tennessee in Congress. The Senator held that this report should have been made to Congress instead of to the licensees.

The analysis of the survey made by Major Fiske disclosed the possibility of building 100 dams on the Tennessee River and its tributaries, conserving the annual rainfall of the Southern Appalachian Mountains. This development, as proposed, would be much greater than is possible on the American side of Niagara, it is reported. It is also stated that Muscle Shoals power is the corner stone of this regional development, and that every dam will increase the regularity of power at Wilson Dam.

Announcement was made in the *Times* on Dec. 14 that two of the larger power companies, the Tennessee Electric Power Co. and the Knoxville Power & Light Co. had withdrawn their applications. This withdrawal leaves the Tennessee Hydro Electric Co. and the East Tennessee Development Co. the remaining applicants. Major Fiske pointed out that the four original applications for dam sites overlapped. The total installation of the sites applied for is somewhat less than 1,000,000 hp., he stated.

Development Power Study Made by Conference Board

The National Industrial Conference Board, 247 Park Ave., New York City, has been making some comparative studies of the development of primary power in the United States. It says:

"Primary power available in manufacturing industries, mining, agriculture and on the railroads today exceeds 150,000,000 hp. Of this, nearly one fifth, or about 33,000,000 hp., is available in the manufacturing industries, as against 2,346,142 hp. in 1869, the earliest date covered by the study.

Since 1899, or during the last quarter of a century, installed primary power in manufacturing industries increased 236 per cent, while the number of wage earners increased only 90 per cent and the volume of production 185 per cent. While data concerning the "real" wage, that is, the purchasing power of workers' earnings, as far back as 1899 are lacking, the purchasing power of average weekly earnings in the United States today is 28 per cent greater than it was in 1914. Although at the beginning of the century there was only 2.14 hp. behind each worker in industry, in 1923 the horsepower per wage earner was 3.33[1] an increase of 56 per cent. The total primary power available in manufacturing industries in 1923 was 33,094,228, of which slightly more than 50 per cent was steam power and about 40 per cent was electric motor power run on purchased current. The rapid increase in the use of electrical power is shown by the fact that whereas in 1869 less than one-half of one per cent of the installed power in manufacturing industries consisted of electric motors, run by either purchased or generated current, in 1923 67 per cent, or more than two-thirds of the total primary power, was represented by electric motors run by purchased or generated current.

[1]This includes salaried employees.

Surplus Canal Water Brings $10,000

The New York Water Power Commission has authorized the issuance of a license covering the surplus canal waters at Medina to the Western New York Utilities Company, Inc., and S. A. Cook & Co., jointly.

The terms of the license is for thirty years at an annual rental of $10,000, subject to readjustment at the end of each ten-year period, and the use of the water is at all times under the control of the State Superintendent of Public Works and subject to its prior use for navigation.

Heretofore no rental has been received for these waters, although power plants have used them for a number of years.

Laundry Boiler Explodes in Fort Collins

The explosion of the boiler at the Linden Wet Wash plant at Fort Collins, Colo., caused the death of the 60 year old proprietor, Anthony Drees, and of his son, Edward Drees, aged 34 years. Three of the employees were seriously injured.

According to reports in the press the explosion is believed to have been due to low water in the boiler. The boiler, which weighed five tons, was torn to pieces, one large piece going through the roof of a house and mashing in a bed, which, had the bed been occupied, would have added another fatality. Other pieces of the boiler were hurled a quarter of a mile beyond the Cache la Poudre River. The building was demolished with a loss of about $16,000.

Operating Engineers Start Merit Study System

The National Association of Stationary Engineers has issued a bulletin giving the details of the merit system of education for stationary engineers recently inaugurated by them. This plan of study is being put out by the association in an effort to get the operating engineers to increase their knowledge of power-generating equipment so that they may be better able to meet the exacting requirements demanded of power-plant men today.

There are to be ten or more courses of study for the completion of which one or two, practical or technical, certificates of merit will be given: Steam; refrigeration; combustion; electrical; internal-combustion and oil engine; supervising engineer; heating and ventilation; mechanics and hydraulics; shop practice; portable and hoisting engines. Each course is to be divided into ten sections of 50 questions each.

Any member of a subordinate association or a non-resident member of the N.A.S.E. is eligible. Every student must pass an examination in mathematics before taking up an engineering course. To receive the certificate of merit he must have had at least five years of actual operating experience; pass examinations, etc., with an average grade of 90 per cent; have been a member of the N.A.S.E. for one year and conform with certain rules for the conduct of the course. The persons interested should address the secretary of the National Educational Committee, Frank T. Sleeth, 2941 Blaine Ave., Detroit, Mich., for detailed information in regard to these courses.

Power Show in New England in April

The New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass., as is its custom every two years, is holding a Power Show in connection with the International Textile Exposition at the Mechanics Building in Boston from April 12 to 17.

The membership of the different societies associated with the Affiliated Technical Societies of Boston have been invited to attend and some of the members invited to read papers along their various lines. Guests' tickets will also be sent to the operating engineers of New England.

Obituary

H. W. Morley, a proprietor of Cole, Marchant & Morley, Ltd., a firm manufacturing Diesel Engines, Bradford, Eng., died on Nov. 19. Mr. Morley developed the drop piston valve type of steam engine and invented an ingenious piston valve with restrained rings. As the pistons had to drop quite freely and yet be steam-tight, the slightest distortion of the liners either by heat changes or mechanical means had to be prevented and Mr. Morley went into the problem with thoroughness and mechanical genius. In 1912 the firm took up the manufacture of Diesel engines. Mr. Morley's health, however, became such that he had to retire from active business in 1913, but he still carried on a consulting business for a few firms and mills in Bradford. He was a member of the Institution of Mechanical Engineers and one of the founders of the Bradford Engineers' Society.

Personal Mention

Prof. and Mrs. L. P. Breckenridge are spending the winter in California. They expect to sail again for Italy in April.

D. L. Bellinger has been elected president of the Mount Morris Valve Corp. and is now located in New York City.

C. I. Crippen has resigned as assistant to the vice-president and general manager of the Pennsylvania-Ohio Electric Co., to become operating manager of Stevens & Wood, Inc., with headquarters in New York City, having charge of the operation of the public utilities managed by that organization.

A. Kristian Bak, technical engineer at the Trenton Channel plant of the District Edison Co., is returning to Copenhagen, Denmark, after a stay of six years in the United States. Mr. Bak will engage in the operation of the municipal power organization, which has recently begun the construction of a new plant. Part of his duties will include the introduction of American methods of power-plant operation.

Col. Elliott H. Whitlock, a prominent member of the A. S. M. E., has been appointed Smoke Commissioner of Cleveland, Ohio.

John A. Foulks has opened a consulting engineering office in Newark, N. J. He was formerly chief engineer of the water department in that city.

Ed. Luxemberg, formerly with the Ashley Street Station, has become the new mechanical superintendent in charge of operation at the Cahokia Station of the Union Electric Light & Power Co., St. Louis, Mo.

Dr. Parke Rexford Kolbe, formerly president of the Municipal University of Akron, Ohio, will be installed as the new president of the Polytechnic Institute of Brooklyn on Jan. 13 in the Opera House of the Academy of Music, Brooklyn, N. Y.

Jesse Ditson, mechanical engineer for the Ingersoll-Rand Co. at Littleton, Colo., has been elected a fellow of the Royal Society of Arts, England. Mr. Ditson is an inventor and has improved methods for hoists, rock drills and furnaces. He is a member of the A. S. M. E.

Dr. Michael I. Pupin, president of the A.I.E.E., will give an address on "The Relations Between Pure and Applied Science," at the coming meeting of the American Association for Advancement of Science which is to be held at Kansas City, Mo., Dec. 30-Jan. 2.

A. H. Smith, chief engineer of the Nova Scotia Power Commission, has resigned from office and **Harold S. Johnson**, hydraulic engineer on the staff of the Power Commission for several years, has been promoted to fill the vacancy. **J. Lumdsen**, electrical engineer on the Power Commission staff, has been promoted to the office of assistant chief engineer.

G. F. Klein, formerly in charge of Cahokia Station of the Union Electric Light & Power Co. at St. Louis, and for many years connected with the company as superintendent of isolated plants, and the steam-engineering departments as assistant chief engineer, has entered the service of the Staley Manufacturing Co., Decatur, Ill., as chief operating engineer of the company.

Business Notes

The Chicago Fuse Manufacturing Co., Laflin and 15th Sts., Chicago, Ill., has moved its Detroit office to 429 Wayne St.

The General Electric Co., Schenectady, N. Y., announces that George P. Baldwin, general merchandising manager of the company, has been elected vice-president in charge of activities connected with the electrification of steam railroads. He will be succeeded by Charles E. Patterson, vice-president, who will take charge of all merchandising activities of the company, including the supervision of the supply houses. Mr. Patterson will make his headquarters in Bridgeport, Conn. W. E. Brown has been appointed as district manager of the central station department of the New York district for the company.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces that the part of the sales force handling specifically steam equipment will be moved from East Pittsburgh to South Philadelphia and will, along with the engineering and manufacturing staffs, report to H. T. Herr, vice-president of the company.

The Bernitz Furnace Appliance Co., 80 Federal St., Boston, Mass., has recently established a branch office at the Bellevue Court Bldg., Philadelphia, Pa., with C. H. Schroder as district sales manager and O. S. Carter as sales engineer. This office will take care of Pennsylvania, Virginia, Delaware, Maryland and the District of Columbia. An office has also been opened by this company in the Book Bldg., Detroit, Mich., for the Michigan territory, with L. R. Leatherman as district sales manager.

Trade Catalogs

Gages—The Bristol Co., Waterbury, Conn. Bulletin No. 339 covers with many photos as well as with descriptions, the water-level gages for steam boilers manufactured by the company.

Boiler — The Heine Boiler Co., St. Louis, Mo. The November "Safety Valve," the house organ of the company, describes the Heine S-type boiler with seamless steel sectional header recently designed.

Motors — Induction — Reliance Electric & Engineering Co., Cleveland, Ohio. Type "A" induction motors for two- and three-phase alternating-current circuits are described in Bulletin No. 5018, third edition.

Conveying Machinery — The Brady Conveyors Corp., 20 West Jackson Blvd., Chicago, Ill. Bulletin No. 21, well illustrated, contains descriptions of some of the elevating and conveying machinery built by this company.

Furnace Arch—McLeod & Henry Co., Troy, N. Y. Bulletin No. 162, issued recently, describes and pictures the flat suspended furnace arch composed of blocks made from "steel mixture" material manufactured by the company.

Boiler Feed Water — Power Plant Specialty Co., "Data on Water for Boiler Feed Use Under Conditions of High Pressures and Overloads" is the title of Bulletin 110 which describes the Vater constant temperature water-softening system.

Stoker, Hand—McClave-Brooks Co., Scranton, Pa. A description of the new design of hopper-feed hand stoker for bituminous fuel is contained in a bulletin recently published by this company. The illustrations show the operation and the adaptability to all types of boilers.

Boilers—Andrews-Bradshaw Co., 530 Fourth Ave., Pittsburgh, Pa. "Concentration in Boilers," by Grant D. Bradshaw, is the name of the paper read before the Engineering Society of Western Pennsylvania and reprinted from the Proceedings of the Society by the Andrews-Bradshaw Co. as Bulletin No. 36.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Boiler Manufacturers Association—Meeting at City Club, Cleveland, Ohio, Feb. 12.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Lead D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Plisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, American Exposition Palace, Jan. 26-30.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Recording Instruments—Evershed & Vignoles, Ltd., Action Lane Works, Chiswick, London, W4. A catalog "Modern Recorders," adequately illustrated, has recently been published by this firm, which contains information on peak load recording ammeters traction recorders, integrating weight recorders, recorders for suction grain elevators and recording "Dionic" water testers.

Pyrometers — Taylor Instrument Companies, Rochester, N. Y. A new catalog, Part 4,000, well illustrated, covering the principle of the thermo-electric pyrometer and the "Tycos" types of instruments in particular, has recently been published by this firm. Useful tables of temperature millivolt equivalents, melting points of chemical elements and other standard temperatures, thermal value of various fuels and industrial temperatures are included.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Dec. 14 1925
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	2.22
Clearfield	Boston	1.75@ 2.10
Somerset	Boston	1.85@ 2.25
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.65@ 2.00
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.65
Central, Ill.	Chicago	2.25@ 2.35
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	2.00@ 2.25
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	....

FUEL OIL

New York—Dec. 17, light oil, tank-car lots; 28@34 deg. Baumé, 5@5½c. per gal.; 36@40 deg., 5¾@6½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—Dec. 8, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.3c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Dec. 15, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Dec. 12, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Dec. 10, 27@30 deg., $2.31@$2.37 per bbl., 18@22 deg., $1.75@$1.81; 13@19 deg., $1.65@ $1.71 per bbl.

Boston—Dec. 14, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.55c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Dec. 14, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6⅝c. per gal.; 26@30 deg., 7c. per gal.; 30@32 deg., 7¼c. per gal.

Chicago—Dec. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Calif., Ontario—City, O. S. Roen, Service Mgr., is having plans prepared for the construction of a 10,000,000 gal. reservoir, 2 deep wells, 2 pumping plants, one booster unit, water mains, etc. Estimated cost $125,000.

Calif., San Mateo—E. Getz, De Young Bldg., San Francisco, is having plans prepared for the construction of a 10 story hotel on 3rd Ave. here. Estimated cost $1,100,000. W. H. Weeks, 369 Pine St., San Francisco, is architect.

Fla., Daytona Beach—Yourlando Land & Development Co., is in the market for a heavy duty gasoline pump to operate artesian well 4 in., 400 ft. deep.

Ga., Atlanta—T. K. Knight Co., 61½ Forsyth St., awarded contract for the construction of a 60 ton daily capacity ice plant to Barge-Thompson Co., 61½ North Forsyth St. Estimated cost $125,000.

Ga., Sandersville—T. L. Martin, plans the construction of two 20 ton electrical units to ice plant. Private plans.

Ill., Chicago—Davis Hotel Co., c/o Rissman & Hirschfeld, 64 West Randolph St., Archts., plans the construction of a 14 story hotel at Walton Pl. near North Michigan Blvd. Estimated cost $3,000,000.

Ill., Chicago—Fairfax Apartment Building Corp., c/o J. A. Nyden, 190 North State St., Archt., awarded general contract for the construction of a 10 story hotel at Hyde Park Blvd. and Dorchester Ave., to J. A. Lundstrum, 5153 North Clark St. Estimated cost $1,250,000.

Ill., Chicago—J. Morton, 80 East Jackson Blvd., awarded contract for the foundation, masonry, etc., for a 21 story office building at Washington and Wells Sts., to Ericsson Co., 139 North Clark St. Estimated total cost $2,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Archts., will award balance of contracts.

Ill., Chicago—Poor Hand Maids of Jesus Christ, 4900 Thomas St., is having preliminary plans prepared for the construction of a 4 story hospital at Lavergne and Lamon Aves. and West Division and Thomas Sts. Estimated cost $1,000,000. H. J. Gaul, 228 East Superior St., is architect.

Ill., Decatur—City will soon receive bids for new generators for municipal electric plant. Estimated cost $70,000. M. P. Obrien, is city engineer.

Ill., East St. Louis—Broadway-Central Hotel Corp., 700 East Broadway, awarded contract for the construction of a 6 story hotel at Broadway and Fourth St. to Widmer Engineering Corp., Laclede Gas Bldg., St. Louis, Mo. Estimated cost $1,100,000.

Ill., Evanston — Four Hundred Twenty Two Davis St. Corp., c/o A. S. Hecht, 155 North Clark St., Archt., awarded contract for the construction of a 7 story hotel at Davis St. and Himan Ave., to Paschen Bros., 111 West Washington St., Chicago. Estimated cost $2,000,000.

Kan., Topeka—Christ Hospital, 9th and West Sts., will receive bids about Jan. 6 for the construction of a hospital including power house, swimming pool, etc. Estimated cost $500,000. Schmidt Garden & Martin, 104 South Michigan Ave., Chicago, Ill., are architects.

Mass., Framingham—H. A. Laing Motor Co., Waverly and South Sts., is in the market for a two cylinder air compressor and motor.

Mich., Detroit—P. Kamper & R. L. Spitzley, Kamper Bldg., will soon award contract for the construction of a 15 story hotel including steam heating equipment at Woodward Ave and Adelaide St. Estimated cost $2,500,000. L. Kamper, Kamper Bldg., is architect.

Mich., Detroit—C. H. Miles, Griswold and State Sts., plans the construction of a 16 story theatre and hotel including steam heating equipment on Adams Ave. P. R. Pereira, 333 State St., is architect.

Mich., Detroit—Public Lighting Comm., 174 East Atwater St., plans the construction of electric sub-station No. 11 in connection with new power and lighting station on Morrell St. Smith, Hinchman & Grylls, 800 Marquette Bldg., are architects and engineers.

Mich., Highland Park (Detroit P. O.)—H. Silverman, 1101 Lafayette Bldg., Detroit, plans the construction of an 8 story apartment including steam heating boilers etc., at Woodward and McLean Aves. here. Estimated cost $3,000,000. M. Finkel, 1333 Book Bldg., Detroit, is architect.

Miss., Meridian—Kaye-Kepsher Ice Co., Inc., J. B. Tutt, Secy. and Treas., awarded contract for the construction of an ice plant at 7th St. and 36th Ave. to McArthur & McLemore. Estimated cost $75,000.

Miss., Moss Point—City plans election Jan. 5 (extended date) to vote $135,000 bonds for improvements to waterworks system including 100,000 gal. tank on tower, 800 ft. well, storage reservoir, oil burning pumping equipment, etc. H. A. Mentz, Hammond, La., is engineer.

Mo., St. Louis—Bd. of Aldermen, E. E. Wall, Director, c/o Dept. of Public Utilities, authorized the construction of a 20 unit 80,000,000 g.p.d. filtration plant including two 30,000,000 g.p.d. pumps, two 40,000,000 and one 60,000,000 g.p.d. pumps, water tube drum type boilers, ash handling equipment, etc. Estimated cost $1,225,000, $412,500, $237,500 and $525,000 respectively.

Mo., St. Louis—W. H. Smith & Nelson Cunliff Co., 117 North 7th St., plans the construction of a 10 story apartment at 3438 Russell Blvd. Estimated cost $500,000. Work to be done with owners forces.

Neb., Omaha—Pacific Fruit Express Co., 1415 Dodge St., will purchase 5,000 new refrigeration cars during the year, to be delivered by Sept., 1926. Estimated cost $16,000,000.

Neb., Omaha—St. Joseph Hospital, 10th and Castellar Sts., awarded contract for the construction of an ice and refrigeration plant including machinery at 10th and Castellar Sts. to Parson Construction Co., 404 Arthur Bldg. Estimated cost $55,000.

N. J., Gloucester—Forrest Mercerizing Co., awarded contract for the construction of a manufacturing plant including boiler house, etc. at Essex St. and Pennsylvania R.R. to E. E. Hollenback Inc., 1824 Brandywine St., Philadelphia, Pa. Estimated cost $50,000.

N. J., Rahway—Bd. of Water Commissioners, plans improvements to waterworks including pumping equipment, etc. Estimated cost $163,000. T. A. Fyffe is mayor.

N. J., Totowa (Paterson P. O.)—Dept. of Institutions & Agencies, B. G. Lewis, Comr., will receive bids until Dec. 29 at office of Division Architecture and Construction, 643 Broad St., Newark, for the construction of a group of buildings including laundry, heating and refrigeration plant, electric elevators, etc., at Training School for Feeble-Minded Females here. Estimated cost $1,000,000. A. B. Mills, State Office Bldg., Trenton, is architect.

N. Y., Brooklyn—Shampan & Shampan, 188 Montague St., Archts., are preparing plans for the construction of an apartment at Ocean Ave. near Avenue I. Estimated cost $800,000. Owner's name withheld.

N. Y., New York—I. Baer Corporation, c/o Gronenberg & Leuchtag, 450 4th Ave., Archts., is having plans prepared for the construction of a 31 story hotel at 56th St. and 7th Ave. Estimated cost $6,000,000.

N. Y., New York—Bronx Hospital, Fulton Ave., is having plans prepared for the construction of addition to hospital. Estimated cost $750,000. L. A. Abramson, 46 West 46th St., is architect and engineer.

N. Y., New York—D. Friedberger, 1261 Broadway, awarded contract for the construction of a 22 story hotel on East 77th St. to G. R. Davis, 30 East 42nd St. Estimated cost $2,000,000.

N. Y., New York—W. Salmon, 17 West 42nd St., awarded contract for the construction of an office building on West 43rd St., to C. T. Wills, Inc., 206 5th Ave. Estimated cost $5,000,000.

N. Y., New York—S. Schack, c/o Moore & Landseidel, 148th St. and 3rd Ave., Archts. and Engrs., is having plans prepared for the construction of an apartment on Macombs Road. Estimated cost $1,000,000.

N. Y., New York—Two Hundred Twenty Five West Seventy First Street Corp., c/o R. Candela, Archt. and Engr., 200 West 72nd St., is having plans prepared for the construction of a 16 story apartment at 256 West 100th St. Estimated cost $750,000.

N. C., Oxford—White & Dickerson Cotton Gin Co., G. M. White, is in the market for a 10 ton ice plant, electric power.

O., Berea — L. Fowles, Clk., is having preliminary plans prepared for the construction of an electric light plant and addition to filter house and 800,000 gal. pumping unit for waterworks. Estimated cost $50,000 and $75,000 respectively. G. Champe, Nasby Bldg., Toledo, is engineer.

O., Cleveland—The American Steel & Wire Co., Rockefeller Bldg., awarded contract for the construction of a 10,000 kw. power station and pump house on Cuyahoga River to J. J. Cassidy, 9718 Baltic Road. Estimated cost $40,000.

O., Cleveland—City awarded contract for the substructure for a pump house, to American Construction Co., Marion Bldg. $309,000.

Okla., Kingfisher — City voted $40,000 bonds for two new boilers, steam turbine, cooling system, circulating pumps, condenser, etc., for municipal light plant. Engineer not selected.

Pa., Pittsburgh—Consolidated Ice Co., 13th and Pike Sts., plans the construction of a 2 story addition to ice plant on Brushton Ave. Estimated cost $100,000. Private plans. Owner will build by separate contracts.

Pa., Pittsburgh — P. Miller, Inc., 600 Majestic Bldg., Detroit, Mich., awarded contract for the construction of an 11 story apartment at 5th Ave. and Dithridge St., here, to Everett Winters Co., 1024 Book Bldg., Detroit, Mich. Estimated cost $3,000,000.

R. I., Pawtucket—School Board, Room 201, Masonic Temple Bldg., will receive bids until Dec 23 for the installation of a heating system including vacuum piping system in new $1,000,000 high school. Estimated cost $25,000. R. C. N. Monahan, 255 Main St., is engineer.

Tex., Dallas—Southwestern Bell Telephone Co., Broadway and Locust St., St. Louis, Mo., is having preliminary plans prepared for the construction of a 10 story administration office building here. Estimated cost $1,000,000. Private plans.

Tex., Denton—Crystal Ice Co., awarded contract for the construction of a 35 ton daily capacity ice plant to F. J. Johnson, 2409 East 1st St., Austin. Estimated cost $90,000.

Tex., San Antonio—H. C. Thorman, 135 East Travis St., is having preliminary plans prepared for the construction of a 10 story apartment. Estimated cost $500,000. Phelps & DeWees, Gunter Bldg., are architects.

Tex., Texarkana—J. N. Myers, will build a 25 ton ice plant by day labor. Estimated cost $65,000. Private plans. Electrically driven machinery, etc., will be installed.

Tex., Victoria—Cuero Light & Power Co., subsidiary of Texas Central Power Co., Frost National Bank Bldg., San Antonio, has purchased the ice plant of the Cuero Ice & Bottling Works and plans the installation of new motor-driven ice making machinery. Private plans.

W. Va., Kenova—Jeffrey-Dewitt Insulator Co., J. F. Sinclair, Mgr., plans the construction of a new building to house a 300,000 to 500,000 v. electric testing transformer. Estimated cost $40,000.

Wis., Berlin—Wisconsin Power & Light Co., 16 North Carroll St., Madison, is receiving bids for rebuilding power plant, new switchboard, etc., here. Estimated cost $25,000. Private plans.

Wis., Milwaukee — City, J. Schwada, Engr., is having plans prepared for the construction of additions to North Point pumping station for boiler room, chlorine room, etc., on Terrace Ave. Estimated cost $400,000. Judell & Bogner, 445 Milwaukee St., are architects. Cahill & Douglas, 217 West Water St., are engineers. New boilers, stokers, etc., will be required.

Wis., Milwaukee — E. R. Liebert, 49 Oneida St., Archt., is receiving bids for the construction of an engine and blower house on 27th St. Estimated cost $40,000. Owner's name withheld.

Ont., Amherstburg—A. J. Woods, is interested in prices of equipment for artificial ice plant. Estimated cost $25,000.